THE AMERICAN JOURNAL OF ROENTGENOLOGY

VOLUME VII

THE AMERICAN JOURNAL OF ROENTGENOLOGY

[FOUNDED IN 1906 AS THE AMERICAN QUARTERLY OF ROENTGENOLOGY]

EDITED BY H. M. IMBODEN, M.D.

VOLUME VII

1920

JANUARY TO DECEMBER

NEW YORK

PAUL B. HOEBER, PUBLISHER

1920

CONTENTS OF VOLUME VII

ORIGINAL ARTICLES

THE AMERICAN JOURNAL OF ROENTGENOLOGY

Editor, H. M. Imboden, M.D., New York.

VOL. VII (NEW SERIES) JANUARY, 1920 No. 1

A PLEA FOR THE USE OF THE FLUOROSCOPE IN THE EXAMINATION OF THE HEART AND GREAT VESSELS*

BY JAMES G. VAN ZWALUWENBURG, B.S., M.D.

Professor of Roentgenology, University of Michigan Medical School

ANN ARBOR, MICH.

WITH the return of our medical officers from abroad we are hearing tales of the greater prowess of the roentgenologists of Europe in the use of the fluoroscope, and it seems to me that the present is a fitting occasion to remind you of the many advantages of this method of examination.

It has always been a matter of regret that I found so few roentgenologists practicing in this field in spite of the vast amount of work, and of the refinements of technic which have been developed abroad. To these I offer no new additions, and you will find practically everything that I shall speak of to-day fully discussed by Vaquez and Bordet, by Franz M. Groedel, Dietlen, and others. After having used the fluoroscope for a matter of twelve years, I confess to feeling some irritation at finding the teleroentgenogram and the estimation of the cardiac area by planimeter hailed as a great advance over previous methods. This involves no criticism of the very excellent work published by Bardeen (and adopted by the army), or the value of the data which he has accumulated. The present paper is intended in no sense as detracting from the value of this method. My position is simply this: That although a numerical expression for the ratio of the calculated cardiac area to the normal in the case of a particular individual is a valuable asset in the estimation of cardiac disease, if one confines himself to this determination he is neglecting many possible observations which are exceedingly valuable to the discriminating mind in determining the type of disease present in the heart.

To my mind, it is not enough to determine the actual size of the heart. One should also attempt to estimate the relative size of the various chambers of the heart, and as I shall attempt to show, this is virtually impossible by radiographic methods. In addition, it is further possible by direct observation of the cardiac movements to gain some idea of the vigor of the heart muscle itself, of its relation to the remaining structures of the thorax not only in a static but in a dynamic sense.

By means of these observations we are then in a position to assist the internist in a determination not only of the actual size of the heart as a whole, but of its individual chambers and of the functional capacity of the muscle.

Of course, everyone realizes that the roentgenologist cannot in every case expect

*Read at Twentieth Annual Meeting of THE AMERICAN ROENTGEN RAY SOCIETY, Saratoga Springs, N. Y., Sept. 3–6, 1919.

to diagnose the ordinary valvular lesions with the same degree of accuracy as a skillful internist. The latter may discover two perfectly diagnostic murmurs indicating two distinct lesions in a given case (since a murmur is qualitative evidence and not quantitative), while the roentgenologist sees but one. The roentgenologist, who is obliged to judge by the consecutive changes in the size and volume of the heart or of its various chambers, finds evidences which are in direct ratio to the volume of the regurgitation, considerable conviction the true pathological sequence. Of course, since the end stages of practically all valvular lesions are determined by the secondary myocardial changes, the distinction in the late stages is relatively much more difficult, and often impossible; but this information becomes of less importance to the internist in the same degree.

Perhaps I can best demonstrate the nature of the information and the character of the deductions which have been found useful by the description of our method of examina-

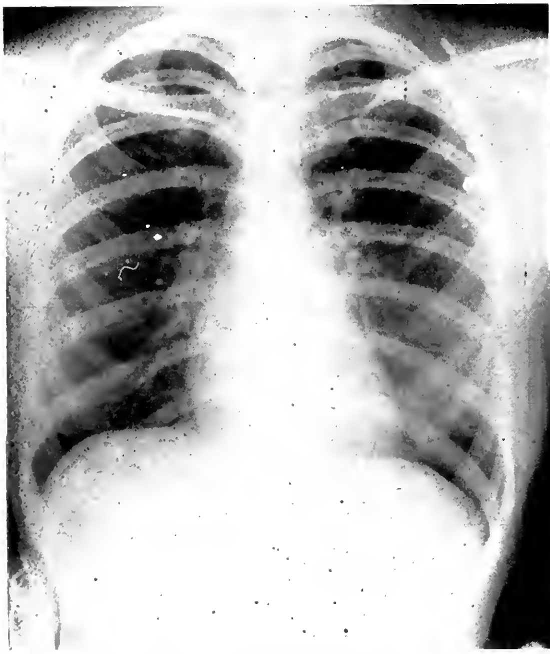


FIG. 1. RADIOGRAM AT 38 INCHES. MITRAL STENOSIS. Note absence of inflections of the border.

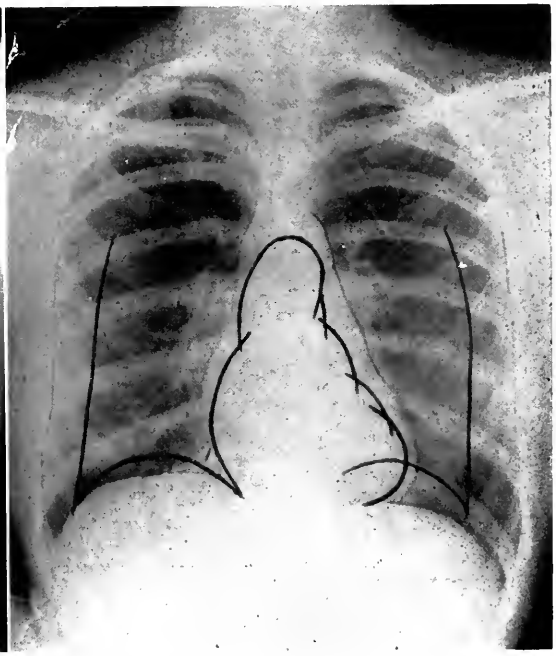


FIG. 2. ORTHODIAGRAM SUPERIMPOSED UPON FIG. 1. Typical "boxing-glove" shape of mitral stenosis.

i.e., quantitative rather than qualitative. In the presence of a major and a minor lesion, it therefore follows that he finds the evidence only of the major and overlooks the minor lesion. The very fact that he fails to discover the minor lesion is of considerable importance to the internist in his prognosis and in the future conduct of his case. In another instance, the internist may be in doubt as to whether the murmur he hears represents an organic valvular lesion or a relative lesion due to a primary disease of the myocardium. In this case the roentgenologist is frequently able to state with

tion. In Fig. 1 is reproduced the radiogram of a case of cardiac disease taken at a distance of 38 inches. This silhouette is roughly comparable to that obtained by the Bardeen method, except in its dimensions, and this focus-plate distance has been selected so that there will be no overriding lines in the subsequent treatment of the record.

You will notice that the cardiac outline is comparatively smooth, although fairly distinct throughout its course. The right border shows the right auricular margin and the right border of the arch of the aorta, the

two normal components of the cardiac silhouette. On the left border the arch and the so-called pulmonary arc are made out with comparative ease. The remainder of the border is made up of the left ventricular border and that portion of the left auricle which normally presents, namely, the auricular appendage. But on the plate we are unable to distinguish the point of division between these two chambers of the heart, and the arc is continuous.

And yet the determination of that particular point is one of the most important data in our determination of the relative size of the chambers.

In Fig. 2 the orthodiagram of this same case has been superimposed in a relatively centered position. You will notice the same outlines on the right side of the heart. On the left side the junctions of the various arcs are represented by rather deep indentations, and the auriculo-ventricular junction is clearly marked. This follows from the fact that in order to determine the course and the direction of intersection of these lines it is necessary to extend these various arcs farther into this cardiac shadow than they are actually seen. Otherwise one would find difficulty in distinguishing between a purely accidental and an intentional departure from a given line of a single dot on the transcription paper. The result of this is that the orthodiagram really is a caricature rather than a faithful likeness of the outline of the heart and to that extent is not entirely truthful. But just as a caricature is intended to bring out the individuality of the person's features, so this caricature of the heart outline makes the distinctive features of its shape more conspicuous and the conclusion more obvious.

The determination of the position of this point rests on the ability to recognize the point at which the ventricular motion differs from the auricular. At this point there is a sort of "walking-beam action" with the formation of a "node of no motion" which is not entirely stationary but moves up and down along the left border. The point is selected at the lowest point of its travel, representing the phase of heart action when the ventricle is contracted and the auricle at least in part dilated. Whatever the exact anatomical position may be, this gives the most nearly characteristic diagrams.

The next figure (Fig. 3) shows the conventional dimensions introduced with the proper notations. We still report the MR and ML dimensions, mainly to satisfy the internist, since by these he checks his percussion. They have, however, a very subsidiary value, depending as they do upon so many factors that can be but poorly

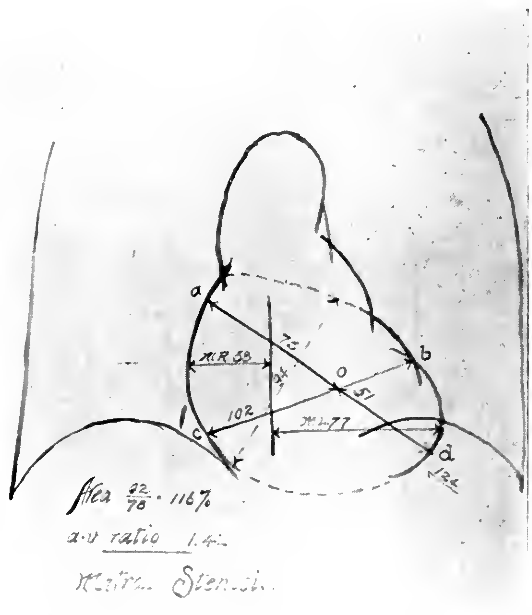


FIG. 3. COMPLETED ORTHODIOGRAM. Actual "area," 92 sq. cm.; average for the patient's weight, 78 sq. cm., a-v ratio, $\frac{ao}{od} = \frac{75}{51} = 1.42$.

evaluated. To a minor degree, the same criticism applies to the ratio of the width of the heart shadow to that of the thorax, recently revived by Shattuck. The oblique diameter also is of doubtful and only indirect value. The long diameter, on the other hand, is of the greatest importance and is the basis of the determination of the area by calculation.

It is only necessary to point out that the so-called oblique diameter extending from the auriculo-diaphragmatic angle to the left

auriculo-ventricular junction roughly corresponds to the dividing line between the auricles and the ventricles. The area above and to the right of this line is therefore a rough index of the auricular area, while that to the left and below represents the size of the two ventricles. In our own work we have attempted to reduce this to a numerical basis by using the ratio of the two segments of the long diameter as intersected by this line (a-v ratio). Normally this ratio is approximately 0.55. With an increase in the auricular area, the value of the a-v ratio rises, the maximum in our experience being 1.42 in a case of mitral stenosis. Per contra, with an increase in the relative size of the ventricles, the denominator of the fraction becomes greater and the value of the ratio diminishes. The minimum in our experience is somewhere in the neighborhood of 0.25 in a case of well compensated aortic regurgitation.

Unfortunately this ratio has many defects. In the first place, the position of the auriculo-diaphragmatic extremity of the oblique diameter is not definitely fixed and depends to a considerable degree upon the level of the diaphragm. So one finds in cases of so-called visceroptosis with a pendulous heart that the right auricular shadow may lie entirely free from the diaphragm, naturally giving a hypothetical or fictitious high value to the auriculo-ventricular ratio. On the other hand, in cases of abdominal obesity and a high position of the diaphragm, this point may lie at a considerable distance above the true auriculo-ventricular junction with a resulting relatively low a-v ratio. In the absence of a definite enlargement, this ratio is almost entirely neglected except as an index to the "posture of the heart."

While the actual numerical expression of these facts is more or less disappointing, we nevertheless find that the basic facts of the position of the left auriculo-ventricular junction and the right auriculo-diaphragmatic junction with respect to the rest of the cardiac area, are of great importance in the estimation of the relative size of the different chambers, and the type of cardiac enlargement.

Further evidence on this point may be obtained by observation of the patient in the right anterior-oblique position, and observing the clear stripe representing the posterior mediastinum. Normally it is of approximately uniform width, and under pathological conditions may be narrowed or obliterated by dilatation (a) of the arch in its upper third, (b) of the left auricle in its middle third, and (c) of the right auricle in its lower third.

Vaquez and Bordet have attempted to estimate the thickness of the ventricles by rotation before the screen until the apex of the heart is tangent to the left border of the vertebral shadow, and by measuring the amount of rotation necessary to produce this. They find that 25 to 35 degrees is normally required. In conditions of left ventricular hypertrophy this angle is considerably increased, even to nearly 90 degrees. In our hands this maneuver has been somewhat disappointing, since the exact angle depends to so great a degree upon the shape of the thorax. One can readily see that in the case of a normal heart in a thorax of round cross-section, the angle would be considerably less than that same heart in a thorax whose cross-section is considerably flattened in the antero-posterior direction. It is possible that the heterogeneity of our population as to race and build may explain our difficulties.

In the estimation of the area of the heart we have been in the habit of continuing the upper border of the left ventricle to join the auriculo-caval junction in a smooth curve and then similarly to close the lower opening of the cardiac shadow. In this way we obviously exclude that portion of the left auricle which projects above the ventricular margin, but we have the advantage of following a line which in many cases is distinctly visible for a considerable distance in the heart shadow. The completion of the lower border is a matter of greater difficulty, both because of the increased distance to be traversed and because of the frequent difficulty in determining the true outlines of the apex. Here I find one must be guided largely by our mental image of the normal

cardiac outline as we habitually see it in the stereoroentgenogram.

The figure so circumscribed is approximately an ellipsoid, and one may calculate its area without danger of great error by applying the formula for the ellipse itself, using as the principal dimensions the long diameter and the greatest dimension which may be erected normal to this line. The product of these values multiplied by $\pi/4$ (.7854) is the approximate area of this figure. We have demonstrated in a series of cases published in the *Archives of Internal Medicine* that the error does not exceed 8 per cent of the planimeter values, and then only in cases of markedly irregular shape and definite hypertrophy, where the error would not cause serious difficulty. To our mind this error is of approximately the same order as the inherent errors of the method, and the accuracy is as great as one needs in so rough an approximation of the area of the heart.

For a number of years we have expressed the size of the heart by the ratio of this area divided by the "norm" for individuals of the same weight. This "norm" was established on approximately seventy-five individuals with apparently sound hearts. When these were plotted in a curve it was discovered that they closely approximated that represented by the following formula: area (sq. cm.) $= 3\sqrt[3]{\text{wgt}^2}$ (lbs.). This is simply an expression of the hypothesis that normally the weight of the heart varies directly with the weight of the body and that the comparable areas on similar volumes vary as the cube root of the squares of these volumes. Neither of these hypotheses hold rigidly, but this approximation again is fairly close and is in singularly close harmony with the values deduced by Bardeen except in the matter of the constant, 3. We find that it adds considerably to the internist's appreciation of the size of the heart if we can tell him that it measures 125 per cent of normal rather than, let us say, 103 sq. cm.

It may be objected that our value does not represent the true area of the heart; but if one can determine the relative size of two bodies by measuring aliquot portions and expressing the same in the ratio of these values, it is a matter of complete indifference what fraction of the whole that aliquot portion may be. The only requirement is that the area be compared with a similar area in a normal individual.

In fact, one might as well compare the products of the long diameter by the longest normal diameter without the use of the factor .7854 as in our method, since this factor occurs in both the numerator and the denominator of the fraction expressing the ratio, and therefore "cancels out." The value of the method is not altered in the least, but the logic is less obvious, and one hesitates to choose a name for such a value. We began by attempting to determine the actual area, and conservatism bids us retain the useless factor.

Clinical experience with this "norm" has led us to believe that this value is a trifle too low. We are in the habit of allowing 110 per cent as the upper limit of normal, and a rather greater number of normal hearts reach 110 per cent than fall to 100 per cent or below. It is a rather remarkable fact, however, that all our observations on cases comparatively normal have fallen between these two values, viz., 100% and 110%.

We are in entire agreement with the usual tables in the matter of the influence of stature, build, age and sex. All of these are of relatively secondary importance except at the extremes, and the estimation of their effect is rarely difficult. A factor which is perhaps of greater importance and which has been little emphasized is the pulse rate. Although it is well known that a heart in tachycardia is considerably smaller than the normal, this factor has rarely been taken into consideration. We believe it of such great importance that when we find a rapid heart with an area which is not less than 100 per cent of the norm, we feel confident of a minor degree of dilatation, and, incidentally, the majority of these cases will be found in obvious or latent cases of hyperthyroidism. So firmly convinced is the internist of this that he hesitates to diagnose hyperthyroidism in the absence of such evidence.

It is exceedingly difficult to formulate a description of changes in the movements

of the heart indicative of muscular weakness, and I shall not attempt to do so here. In a general way one gets a sense of incoordination and futility, and this is usually unmistakable. Together with this there is a shapelessness and irregular deviation from our conception of what the shape of the heart ought to be that rarely leaves one in doubt.

In this connection, one must properly appreciate the influence on the cardiac movements of the relation of the heart to the supporting structures of the diaphragm and the anterior chest wall. Ordinarily the heart is supported in the rather deep trough produced by these structures, as the result of which the lower margin and the apex are relatively fixed in position. You are, of course, familiar with the surprise of the beginner at the relatively small excursion of the apex. This follows from the usual conception that during systole the apex, by the shortening of the long diameter of the heart, approaches the base of the ventricle lying near the midline. As a matter of fact, the greater part of the shortening is accomplished by the descent of the base towards the apex. Lateral movement of the lower border is restricted by the diaphragm. The only free margin of the heart, therefore, which is unrestricted in its movement is the left border, and its motion is due to the shortening of the transverse diameter of the heart roughly from the left and above to the right and downward. In this connection it is interesting to note that the apex as determined by palpation usually lies near the outer extremity of this upper margin.

If, however, the heart lacks the support of the diaphragm, but is freely suspended from its attachment in the mediastinum to the deep fascias of the neck, one finds that the base is relatively fixed, while the apex shows a considerably wider range of motion. The lower border is now free to move, and in fact, the entire outline of the heart partakes of the movement, much of it being a movement of the heart as a whole as a response to the recoil from the effort of expulsion of the blood stream into the aorta, somewhat in the nature of a "backlash." It is my personal conviction that the foregoing fact accounts for many of the symptoms of throbbing and palpitation so common in this type of visceroptotics and neurasthenics.

The appreciation of these changes, however, is a matter of experience, and the conviction with which one draws conclusions concerning the cardiac movements is to some degree a matter of temperament.

We have described at some length our own methods and have tried carefully to avoid making it appear that the examination of the heart is a mere question of mathematics. As a matter of fact, it is not. It is a clinical method, and as such requires all a man's skill and judgment. The skill is not difficult to acquire if one can learn to avoid certain difficulties. I have discovered that virtually all my students are guilty at first of approximately the same errors; that the simplest way to correct those errors is by a systematic comparison of the orthodiagram with a good stereographic pair, and that very soon the student becomes independent of such radiographic assistance.

There are no longer any technical difficulties in the application of this method. A very simple modification will allow one to make orthodiagrams on practically any vertical fluoroscope. There is, of course, the highly important and, to many, the disagreeable feature of the preparation of the retina, for no amount of additional illumination will entirely compensate for the improvement in vision that results from twenty minutes in a darkened room or behind ruby goggles. But to our mind the additional information so obtained abundantly repays the effort, and we entertain the suspicion that this factor has much to do with the reported superiority of European methods.

Bibliography

Vaquez and Bordet. Le Coeur et l'Aorte, Paris.

Franz M. Groedel. Lehman's Med. Atlanten, Bd. vii, Munich.

Dietlen. Ueber Grosse und Lage des normalen Herzens. 23 Kong. für innere Med., 1906.

Van Zwaluwenburg and Warren. The Diagnostic Value of the Orthodiagram in Heart Disease. *Arch. Int. Med.* Feb. 1911, Vol. 7, p. 137.

THE RADIOGRAPHIC FINDINGS IN PERICARDITIS WITH EFFUSION*

BY GEORGE W. HOLMES, M.D.

Roentgenologist to the Massachusetts General Hospital

BOSTON, MASS.

ALTHOUGH the presence of fluid in the pericardium is a comparatively rare finding in the examination of diseases of the chest, the question of its presence or absence often arises, and the radiologist is frequently called upon to express an opinion. The findings upon which to base such an opinion are not clearly defined in the literature, and from the various statements made in a discussion of this subject at the last annual meeting of this society, it would seem that we, as roentgenologists, have no commonly accepted findings in this disease. The studies which are reported in this paper were undertaken with the hope that some of the disputed questions could be answered and the roentgen findings in pericarditis grouped.

As early as 1897, Dr. Francis Williams reported some experimental work on the opacity of the various fluids of the body to *x*-ray. He was unable to differentiate between volumes of pus, ascitic fluid, blood, and water. From his studies he concluded that there is not sufficient difference in the specific gravity of the various fluids and soft tissues of the body to make their differentiation by *x*-ray possible. In his book published in 1903, he discusses the findings in pericardial effusion and states that when the cardiac area is enlarged, we should note carefully whether or not the pulsations of the left border can be clearly followed. If they can, we have to do with an enlarged heart. If not, we should consider pericardial effusion. He further states that the signs in pericardial effusion differ with the amount of fluid present. The larger amount increases the shadow of the cardiac area and obliterates the pulsating outlines of the left border of the heart, and the heart shadow becomes more rounded. In small effusions it should be remembered that the fluid is largely in the most dependent part of the pericardial sac. To detect its presence we must note what change, if any, has taken place in the cardiac outline and whether its outline is modified by change in position of the patient. He recommends the following positions for examination:

"*Sitting position:* Tube behind patient and screen in front of chest; deep inspiration. The lower and posterior border of the heart should be determined as far as possible; if the outline of the triangular area formed by this portion of the heart is not changed, there is probably not much if any pericardial effusion present.

"*Recumbent position:* Deep inspiration. An examination should also be made with the patient lying on his back, and also on his right and left sides, and with the light going through the body horizontally, the tube being on a level with the heart, to determine whether or not in this position there is any modification of the outline of the heart.

"The outline of the heart and the effusion should be drawn during inspiration and expiration."

Dr. Frederick C. Shattuck read a paper on pericarditis before the Association of American Physicians in 1897, in which he called attention to the increased dullness below the clavicle on the left in the front of the chest only, and to changes in the shape of the cardiac dullness with change of position of the patient. He laid considerable stress on the latter finding. He also stated that the impulse may or may not be felt and that the heart is not always forced upward in the front of the chest by the fluid.

In the discussion of this paper, Dr. T. M.

*Read at Twentieth Annual Meeting of The American Roentgen Ray Society, Saratoga Springs, N. Y., Sept. 3–6, 1919.

Rotch spoke of his recent experimental work. He felt convinced, in spite of the general opinion to the contrary, that the heart sank in pericardial effusion, and for this reason was a greater distance than normal from the chest wall. He also spoke of the change in shape of the heart dullness, particularly an increase to the right in the fifth and sixth interspaces, with increasing effusion. He reported his experiments and called attention to the change in the cardio-hepatic angle, known as Rotch's sign. This sign until recently has been generally accepted by clinicians.

Goodrich B. Rodes reviews 62 cases of suppurative pericarditis and discusses the literature up to 1915. He calls attention to the two sinuses of the pericardium, the greater of which is situated to the right of the great vessels at the base of the heart, and the lesser along the right posterior edge opposite the fifth interspace in front. He states that these sinuses are the first to fill when fluid is present and that they have a capacity of 200 c.c. Because of the posterior position of the lesser sinus, when it is filled the heart is pushed forward. This condition he describes as the first stage and states that it is recognizable only by careful radiographic study. The second stage is reached when the pericardium is completely distended. An increase in the amount of fluid beyond this point raises the pressure within the pericardium, and when it eventually reaches a point greater than the intra-auricular pressure there will be interference with the heart beat. This condition he classifies as the third stage. The radiographic findings are not discussed. He shows plates in which there is extreme enlargement of the heart shadow, especially the base, with obliteration of the normal cardiac outlines. The heart is not visible within the pericardium in the case reported, although a quart of pus was removed from the pericardium at operation. He does not say whether he has ever seen the heart shadow within the pericardium.

The standard textbook on physical diagnosis generally includes in the signs of fluid in the pericardium increased dullness, particularly at the base, faint or absent apex impulse, change of the cardio-hepatic angle, and change in the shape of the dull area with change of position of the patient.

From this brief review of the literature, it would seem that there is a rather general agreement among internists and radiologists that with fluid in the pericardium the cardiac area changes both in size and shape, the shape depending upon the amount of fluid present and upon the position of the patient when being examined. The findings are founded upon an anatomical and physical basis. Opinions differ as to the position of the heart in the pericardial sac and the visibility of its pulsations when there is fluid present. None of the authors whom I was able to consult stated whether or not it was possible to visualize the heart within the fluid-filled pericardium by x-ray, or whether its shadow if seen should be negative or positive. Kassabian in discussing the shadow of the heart in pericarditis states that the density is less at the periphery, and that it gradually increases toward the mid-portion. Knox in his book shows an illustration under the heading of "Hypertrophy and Hydropericardium" in which the left border of the heart seems to be visible within the pericardium. He makes no reference to this in the text.

As the roentgen findings in any examination are based on changes in size, shape, density or movement, and on the position of the shadows studied, it is obvious that to add anything to the roentgen diagnosis of pericarditis with fluid not already known and accepted, one must answer the following questions:

1. Is the shadow of the heart visible within the fluid-filled pericardium?

2. What effect does fluid have upon the visibility of the heart beat?

3. What effect has fluid in the pericardial sac upon the shape of the cardiac shadow?

An attempt was made to attack the problems from both the clinical and experimental sides. The records of 60 cases which had been diagnosed more or less positively as pericardial disease were studied

and in addition the following experiments were performed.

Experiment No. 1.—The object of this experiment was the determination of the appearance of the heart shadow when that organ was immersed in fluids of varying specific gravities. The chest of a freshly killed, medium sized dog was opened and the cardiac vessels tied off. These vessels were then severed outside the ties and the pericardium trimmed away. The heart was then removed from the body and suspended by threads inside of a paraffin coated box so that it lacked about an eighth of an inch of touching the bottom. The box was filled successively with substances of six different specific gravities and radiograms made of all six preparations on the same plate under identical conditions. The substances used were air, ether with a specific gravity of 0.727, tap water with a specific gravity of 1.000, salt solution with a specific gravity of 1.012, salt solution with a specific gravity of 1.020, and salt solution with a specific gravity of 1.036. Where fluids were used, enough was put into the box to bring the level just above the uppermost surface of the heart. The following illustration shows the radiograms obtained in this experiment.

Where the heart is suspended in air its outline is, of course, very sharply defined. In ether, the outlines are not so distinct, but they can be easily made out, and it is evident that the animal tissue is less radiant than the surrounding medium. When the box was filled with water, it was just possible to make out the cardiac shadow and its density appeared to be slightly greater than that of the surrounding substance. However, when the water was replaced by the salt solution having a specific gravity of 1.012 and 1.020, respectively, it was impossible to identify the cardiac outlines within the homogeneous shadows cast by the fluids. In the sixth radiogram, where the specific gravity was brought up to 1.036, the heart again became visible, but in this substance its density was less than that of the liquid in which it was suspended.

When a solid body is placed in a liquid, that body sinks if its specific gravity be greater, and floats if it be less than that of the surrounding liquid. When the heart used in this experiment was placed in ether or in water it sank rapidly to the bottom of the container. When it was placed in a vessel containing the salt solution having a specific gravity of 1.036 it floated. In the salt solution having a specific gravity of 1.012 and 1.020, respectively, it tended to float, but after a time sank sluggishly to the bottom of the container.

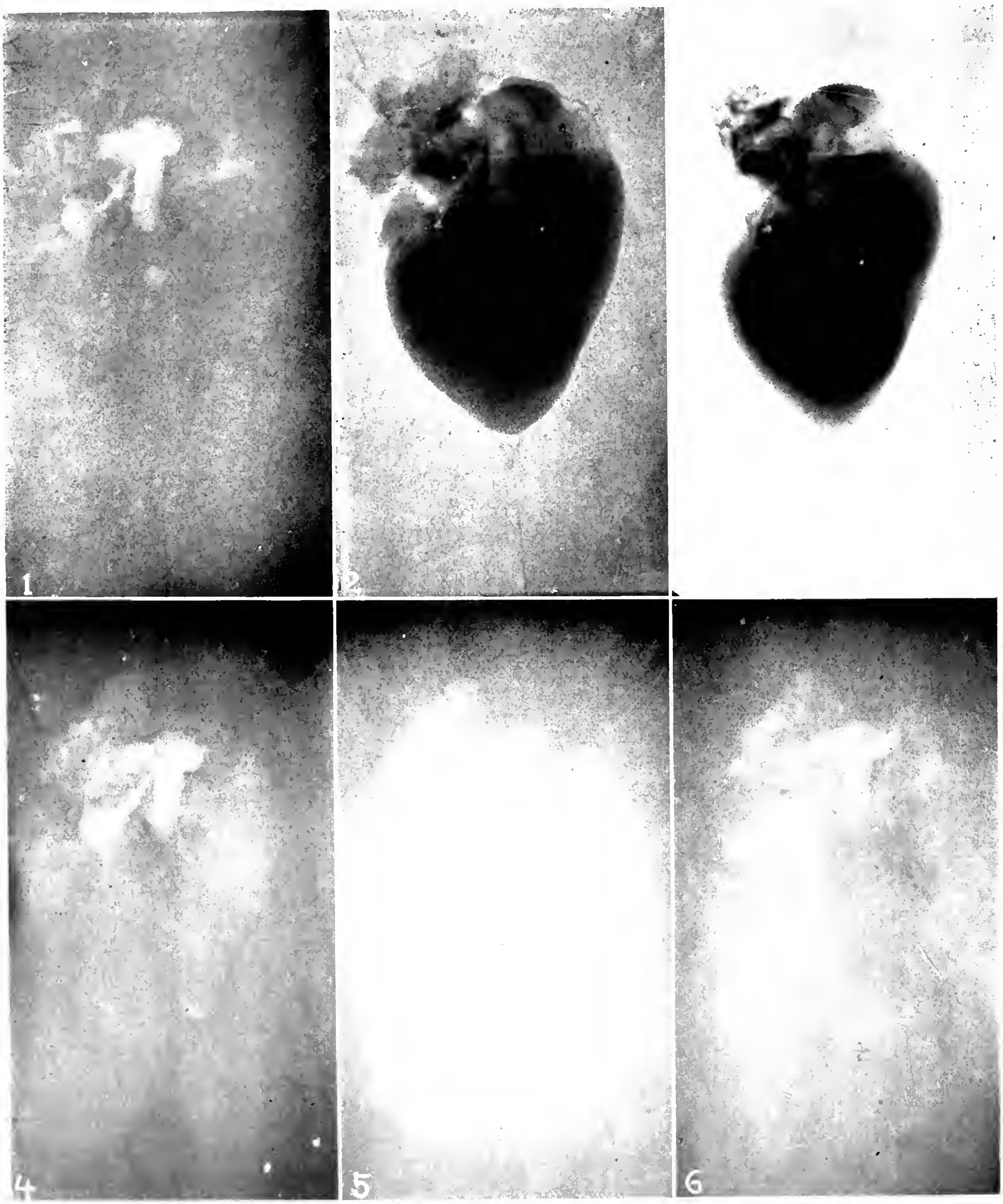
It may be assumed, then, that the specific gravity of the living heart filled with blood is not far outside the range of 1.012 to 1.020. The specific gravity of fluids removed from the pericardial sac in cases of effusion varies but is usually somewhere within the same range, that is, between 1.012 and 1.020.

The beating heart is a moving object and its outlines are not likely to be so clearly shown in a radiogram as are those of a dead heart suspended and immobilized, as in this experiment. Therefore, it would seem that the radiographic demonstration of the human heart in pericardial effusion should be most difficult.

Experiment No. 2.—It was the object of this experiment to demonstrate the change in cardiac outline resulting from the injection of ascitic fluid having a specific gravity of 1.012 into the pericardial sac of a living dog. The animal was etherized and the chest opened near the mid-line. The wide respiratory excursion of the heart made it seem advisable to kill the animal before proceeding further. The hollow needle was then at once pushed through the pericardium and about 150 c.c. of fresh ascitic fluid forced into the sac by means of a syringe. Plates were made before and after this procedure, with the animal on its back. Unfortunately a weak place in the pericardium allowed a hernia-like pouch to form near the left border of the heart. Fig. 2 shows the results obtained. In spite of the mishap, it is possible to see that after the injection the cardiac outline is more rounded, the cardiohepatic angle is not obliterated, and the heart

cannot be definitely made out within the shadow of the distended pericardium.

Experiment No. 3.—The object of this injection of salt solution into the pericardial sacs of cases coming to autopsy. The costal cartilages were cut through and the sternum



This Plate Shows the Results Obtained in Experiment No. 1, to Determine the Appearance of the Heart Shadow in Fluids of Varying Density.

...ment was the demonstration of the ... in the cardiac shadow following the freed and lifted without disturbing the pleura. A rubber tube was then sewn into

the pericardial sac. Salt solution of a specific gravity of 1.012 was forced in with a syringe. The bodies obtained for this work were not very suitable because they had been frozen for some time and the pericardium could be distended only when the fluid was put in under high pressure. As a result, enough fluid was not injected in any of the cases to give the typical picture of pericardial effusion. Fig. 3 shows the heart before and after the injection of about 200 c.c. The curves at the junction of the heart and the great vessels were straightened out, but there was no other apparent change in outline. These plates were made with the subject prone, and it may be that the first change of outline with the patient prone is across the base of the heart in a beginning effusion.

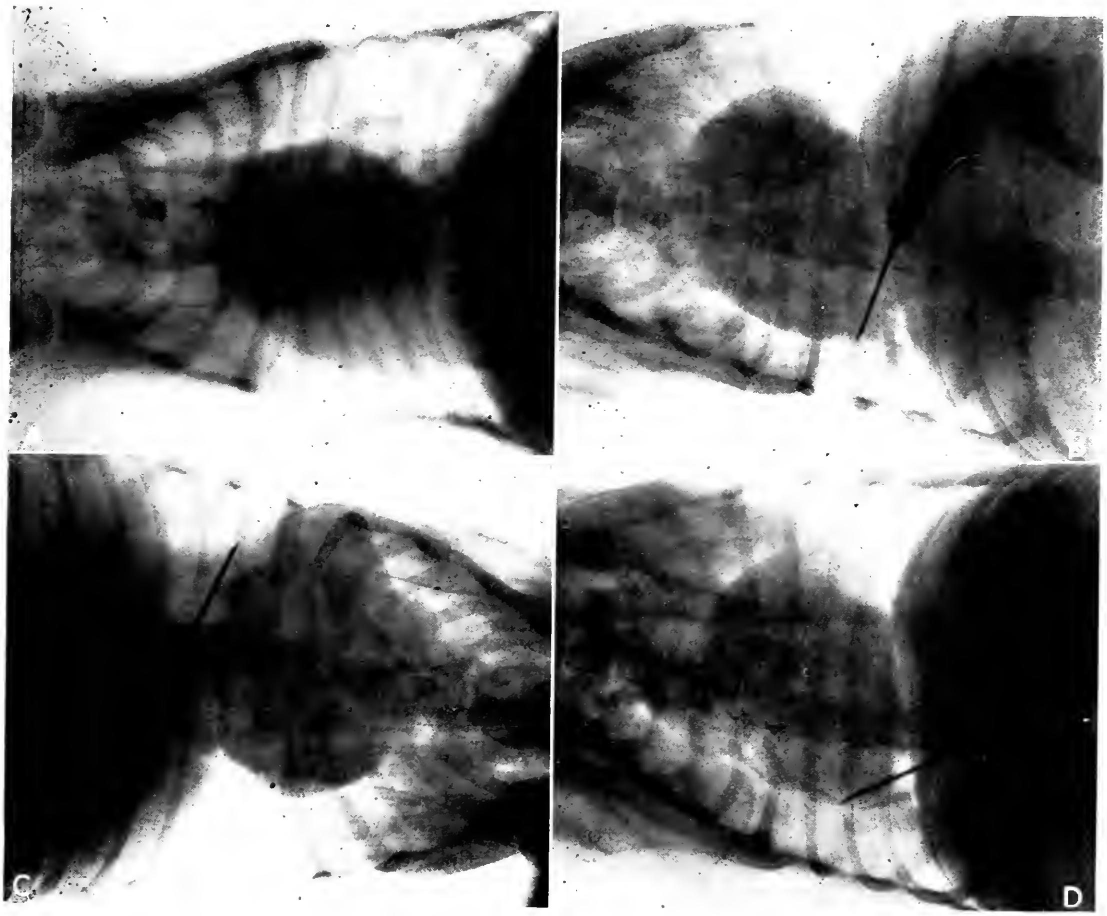


Fig. 2A. This Plate taken with the Animal Lying on his Back, immediately after Etherization.

Fig. 2B. The Position of the Animal is the same as in Fig. 2A. Plate taken after death, and fixation of the needle in the pericardium. It is to be noted that the shape of the heart is changed somewhat—probably due to dilatation of the auricles.

Fig. 2C. Taken immediately after Injection of Ascitic Fluid into the Pericardium. Note the roundness of the shadow, except for the bulge to the left where there is a hernia of the pericardial sac. Just internal to the point of the needle there is a curved line beyond which there is an increase in density. It is possible that this is the heart apex, although its position and shape are different from that seen in the other radiographs.

Fig. 2D. This Plate was taken after Removal of the Ascitic Fluid and Injection of the Pericardium with Air. It shows very well the shape of the distended pericardium and the fact that the cardio-hepatic angle is not obliterated by such distending.

In 1917, Morris and Bader published their studies of artificially produced effusions in cadavers. They injected the pericardial sacs

of four bodies four to sixteen hours after death with varying amounts of ascitic fluid (250-1500 c.c.), and made plates of the cardiac region with the tube at a distance of six feet from the thoracic wall. In summarizing their work they stated that the cardiohepatic angle was never obliterated even after the injection of 1500 c.c., and that the earliest clinical manifestation was an increase in retrosternal dullness which appeared at the same time that the cardiac shadow began to increase in width, and that containing pus it was given as 1.020. Most of these cases were examined over a considerable period of time, so that although the number of cases is small, there are a fairly large number of examinations. In all of the positive cases the heart shadow was very much enlarged, and there was a definite change in shape with change in position of the patient. In two there was sometimes faint but distinct pulsation present, and in the others no record of visible pulsation was made.

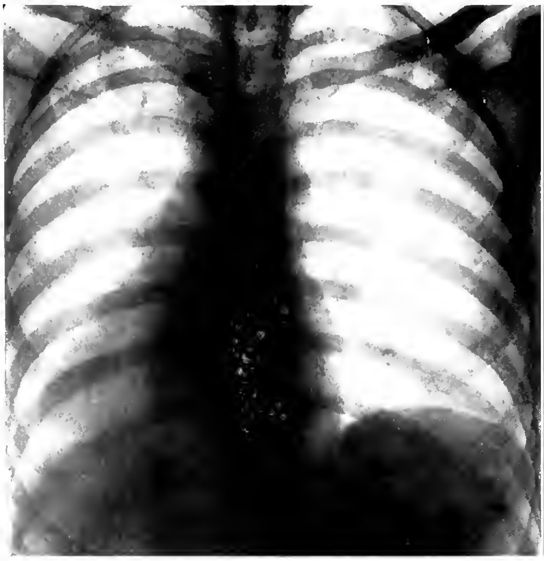


Fig. 3a. This Plate Shows the Results Obtained in Experiment 3 taken before Interference with the Pericardium.

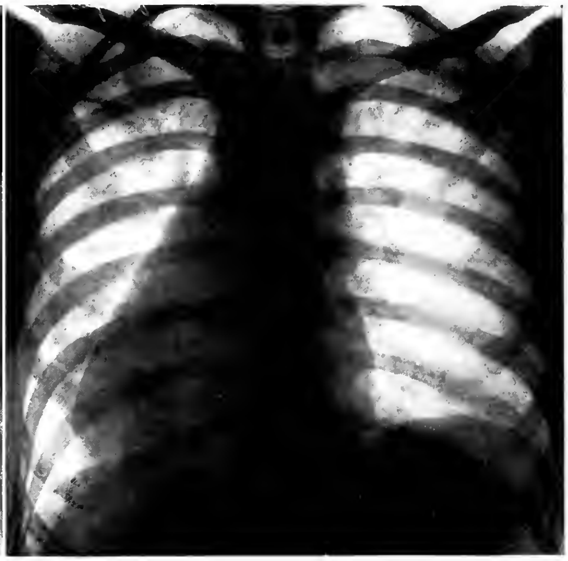


Fig. 3b. After Injection of 200 c.c. of 1.012 Salt Solution. The most striking feature of this plate is the complete obliteration of the normal curves at the left border of the heart shadow.

when the amount of fluid was not too great, it was possible to demonstrate shifting restrosternal dullness with change of position.

CLINICAL STUDIES

Data were obtained from the records of 60 cases diagnosed as probable pericardial disease. In many of them the diagnosis was never definitely confirmed, while in others the condition probably was enlarged heart with adhesive pericarditis. Five, however, had very definite clinical stories and fluid was obtained by tapping. In four the fluid was serous, and in one it was purulent. The specific gravity of the fluid in the first four was not given in the records, but in that

A study of the notes made in these cases gives one the impression that the presence or absence of pulsation in the individual case depends somewhat upon the amount of fluid present. The greater the amount of fluid the less likely are we to see pulsations. In connection with the study of pulsation, I went over the notes on a considerable number of fluoroscopic observations of large hearts which later proved to be due to dilatation. It seemed that absence of pulsation was noted as often in these cases as in the cases proven to have fluid in the pericardium. The cardio-hepatic angle was sometimes acute, sometimes obtuse, and sometimes obliterated. This was equally true

in the cases with dilated heart. Apparently the angle is more likely to be obliterated if the examination is made with the patient in the upright position. The outline of the shadow varies considerably in the different cases. In practically all of them, however, there is an absence of the normal outline of the various chambers, i.e., it is impossible to distinguish the auricle from the ventricle. Also, in practically all the cases, with the patient prone or supine the cardiac dullness rises higher toward the sternal notch and is also increased in width at the base, while when upright, the changes at the base are less marked, and there is a distinct increase in the width of the shadow just above the diaphragm. In several of the cases (including the experimental hearts) there is a distinct bulging of the shadow to the left in the region where the left auricle is usually seen.

Fig. 4a. Plate Taken with the Patient Supine at the Usual Distance Used for Chest Work. Notice the absence of the normal cardiac outline and the tremendous enlargement of the shadow upward and to the left. The cardio-hepatic angle is flattened but not entirely obliterated. After this plate was taken, 90 c.c. of fluid was removed.

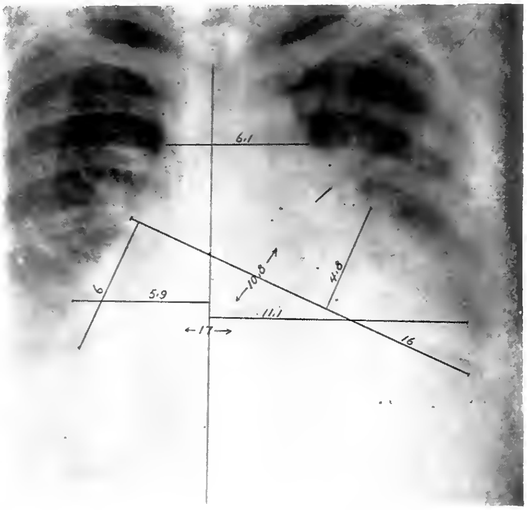


Fig. 4c. Taken in the Same Position as 4a one Month after first Examination. Clinically there was very little evidence of fluid at this time and a pericardial rub was present. The diagnosis of "adhesive pericarditis" was made In this plate the outline of the cardiac shadow is more irregular and the outline of the various chambers still obliterated.

I was unable to get much data on the effect of the fluid on the triangle back of the heart, and in no case was I able to see clearly the diaphragm on the left side, so that I am unable to confirm Williams' observation that in pericarditis with fluid the shadow of the inner part of the diaphragm is obliterated, or the observation of Destot that the pericardial shadow bulges downward below the diaphragm on the left side and can be seen through the gas bubble in the stomach.

Each case was examined several times, and in many a series of a dozen or more plates were taken. While some of the plates were taken at a distance of seven feet during normal breathing, many were made at the usual chest distance with fairly rapid exposures. I re-examined all of these plates in the hope that I should be able to see the outline of the heart shadow within the pericardium, but I was unable to do so. Possibly instantaneous plates would give better results, and where the fluid is of unusual density, with such plates the outline of the heart might be shown.

Pericarditis with effusion must be differentiated from mediastinal pleurisy, cardiac hypertrophy, and dilated heart. Barjon in his book on "Radio Diagnosis of Pleuro-Pulmonary Affections" describes a form of mediastinal pleurisy which he terms "pseudo-pericardial," and shows diagrams illustrating such cases. The mid-chest is

occupied by a large triangular shadow, the apex of which is upward and which from its shape and position resembles very closely the distended pericardium. The shadow of the heart can be seen distinctly through it. The lesion may be anterior or posterior, unilateral or bilateral, and may be combined with diaphragmatic pleurisy or pericardial effusion. But he states it is characteristic of this condition that the abnormal shadow is always superadded to the median shadow, and refers to the work of Devic and Savy who report their studies of mediastinal pleurisy, including a chapter on radioscopic examination by Destot. A point in diagnosis to which Destot calls attention is the disappearance of the heart-beat in mediastinal pleurisy and its presence in pericardial effusion.

If these observations by Barjon are true, mediastinal pleurisy or empyema would account for some of the radiographs in which the heart shadow is distinctly seen within a triangular shadow. Personally, I have never seen such a case.

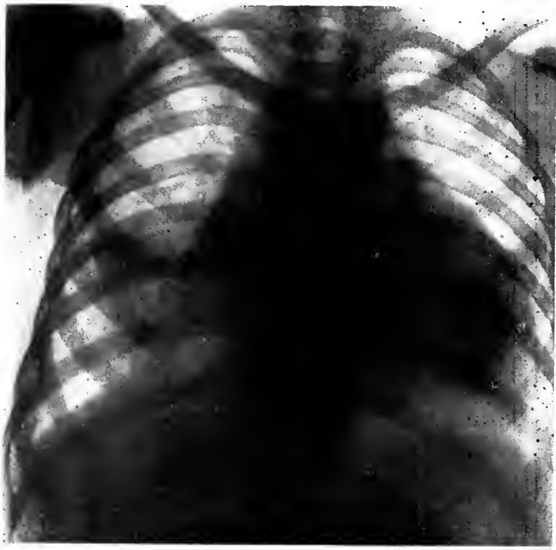


Fig. 5a. Shows Extreme Dilatation of the Heart in a Case of Pneumonia. Note the obliteration of the cardio-hepatic angle. The outline of the normal heart curves is rather indistinct but not as marked as in the plates of "Pericarditis with Effusion." Careful tracings failed to show any evidence of change of level with change of position, and a dry tap was made. The shadow to the right of the heart is due to consolidation in the lung.

Fig. 5b. Same Patient. Shows marked decrease in the size of the heart under treatment, confirming the diagnosis of "dilatation."

The point which Destot makes of the absence of pulsation in the margins of the shadow when it is due to fluid outside of the pericardium seems to me a good one. The shadow of the dilated heart resembles very closely that of pericarditis with effusion. Usually the pulsations are so rapid or faint that they are invisible at the fluoroscopic observation. The shape of the heart shadow is rounded and the costophrenic angle may be acute, obtuse or obliterated, but there is no change in the shape of the heart shadow with change in position of the patient.

This was very well illustrated in one of our cases in which careful tracings failed to show any change in shape but in which the clinical evidence was so strong that the tap was made. No fluid was obtained. After a short rest in bed the heart was reduced to nearly normal size.

With enlargement of the heart due to hypertrophy, the beat is very strong and the division between the various chambers easily discernible. One is not likely to confuse such a heart with pericarditis with effusion. But when hypertrophy of the heart is complicated by an adhesive pericarditis, the diagnosis becomes more difficult. Dr. William H. Smith, in a study of autopsy

records of 62 cases of adhesive pericarditis at the Massachusetts General Hospital, found no case of an enlarged heart due to adhesive pericarditis alone. The heart shadow in these cases is usually enlarged, its outline indistinct, and the markings of the various chambers may be obliterated. Its pulsations are less well defined than normal and its respiratory movements may be somewhat limited. The diagnosis must be made on the absence of change in shape with change of position.

The method of examination described by Williams is so complete that I can add very little if anything to it. When the patient's condition permits, I think it is advisable to take plates at a distance of seven feet, upright and prone, respectively, as this method is fairly free from distortion and is the most accurate way of obtaining evidence of slight change in shape.

SUMMARY

In pericarditis with effusion, it seems to me that the findings may be grouped in the order of their importance as follows:

1. An abnormally shaped heart shadow which changes with change of position of [illegible] observations go. this sign is not present in any other condition.)

2. Obliteration of the normal heart outline.

3. Change in shape of the angle formed by the posterior border of the heart, the diaphragm, and the spine.

4. Faint or absent pulsation.

I wish to express my appreciation of the help given by Dr. Charles L. Martin, who did most of the experimental work, and to Drs. Wright and Richardson for the privilege of using their pathological material.

BIBLIOGRAPHY

WILLIAMS, FRANCIS. The Roentgen Rays in Medicine and Surgery. New York: Macmillan. 3rd Ed. 1903.

SHATTUCK, FREDERICK C. Pericarditis. *Tr. Assn. Am. Physicians.*

RODES, GOODRICH B. Suppurative Pericarditis. *Ann. Surg.*, December, 1915.

MORRIS, ROGER S. and BADER, ELLIS R. A comparison of the Percussion and Roentgen Ray Findings after Injection of the Pericardium. *J. Am. M. Assn.*, Aug. 11, 1917. 450-54.

BARJON, F. Radio Diagnosis of Pleuro-Pulmonary Affections.

[The third article of the Heart Symposium, "The Aviator's Heart," by Dr. L. T. LeWald, and the Discussion of the three articles, will appear in the February issue.]

X-RAY STUDIES OF THE SEMINAL VESICLES AND VASA DEFERENTIA AFTER URETHROSCOPIC INJECTION OF THE EJACULATORY DUCTS WITH THORIUM —A NEW DIAGNOSTIC METHOD*†

BY HUGH H. YOUNG, M.D., AND CHARLES A. WATERS, M.D.

From The James Buchanan Brady Urological Institute, The Johns Hopkins Hospital. BALTIMORE, MD.

THE vast canal system extending upward from the orifices of the ejaculatory ducts in the verumontanum presents a wide field for study hitherto neglected both in Urology and Roentgenology. Only during the past few years has proper attention been paid to the rôle of the seminal vesicles in the production of any one of the numerous types of arthritis, cardiac and gastro-intestinal disturbances and neuroses, and up to the present time the assistance to be derived from the x-ray has been practically disregarded.

Belfield, Mills, Thomas and Pancoast, and Picker, have published excellent roentgenograms showing the vesicles and vasa injected with opaque substances through a vasotomy.

In the present paper we desire to call attention to a method by which the vesicles can be injected through the catheterized ejaculatory ducts following endoscopy; further, to emphasize the fact that, so far as our experience goes, there is no harmful effect associated with this procedure, and

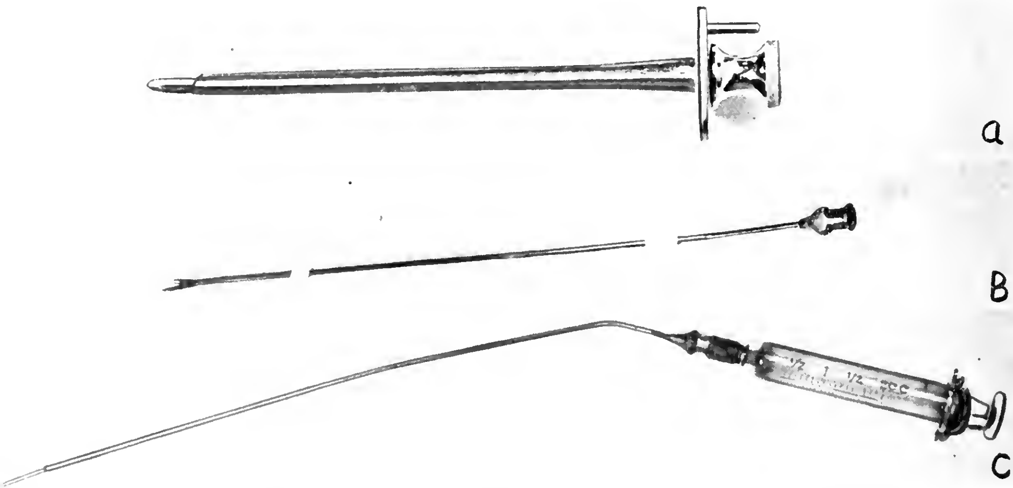


FIG. 1. A. ENDOSCOPE; B. DOUBLE-FORKED CANNULA; C. GERAGHTY'S UTRICLE SYRINGE—ESSENTIAL INSTRUMENTS USED IN THE CATHETERIZATION OF THE EJACULATORY DUCTS. Note the specially devised forked cannula B used in injecting both ducts at the same time. One arm of the fork is 3 mm. longer than the other.

FIG. 2. AFTER THE INJECTION OF THE LEFT SIDE. BOTH VASA DEFERENTIA ARE NOW VISIBLE. The injection can be traced to the approximate location of the internal abdominal ring.

*Read at Twentieth Annual Meeting of THE AMERICAN ROENTGEN RAY SOCIETY, Saratoga Springs, N. Y., Sept. 3–6, 1919.

†Published simultaneously in the *Johns Hopkins Hospital Bulletin*.

lastly to show that by the injection of thorium it is possible to outline this vast canal system above the orifices of the ejaculatory ducts.

It is generally stated in most textbooks that strictures of the ejaculatory ducts do not occur, and as far as we can find in the literature, Luys is the only one who has attempted to explore the interior of the ducts by "catheterism."

For the past four years one of us (Young) has been endeavoring by means of specially devised probes, filiforms, bougies of metal and whalebone, and with Geraghty's utricle syringe (Fig. 1) to explore and treat the interior of the ejaculatory ducts, the vasa deferentia and seminal vesicles, and in these experiments it has been found that the ejaculatory ducts are easy to locate in most cases even when not visible. A special probe will usually pass upward for a distance of two or four centimeters into the vas deferens. In this way many differences in caliber have been discovered and several cases of marked stricture of the ejaculatory ducts have been made out.

In these cases systematic dilatations, dilated at weekly or bi-weekly intervals, have sometimes brought about almost immediate relief of chronic pain and discomfort in that region. In another paper a description of these cases, the methods employed and the results obtained will be given in detail. In the course of this work we have been struck with the need of a method by which the condition of the canal-system above the verumontanum can be graphically depicted without resorting to opening the vas deferens in the groin as has been done by Belfield, Thomas and Pancoast, Mills and others.

Fig. 3. Table Prone with Tube and Compression Attachment in Position.

Fig. 4. Side View of Table in Upright Position.

With the introduction of thorium in making roentgenograms, it occurred to us to

use this agent for the purpose of getting the much desired pictures of the interior of the vasa deferentia and the seminal vesicles. By using Geraghty's utricle syringe, it has been found easy in most cases to inject one or two cubic centimeters of thorium solution and to obtain excellent radiographs of the vasa differentia out to the external rings (Fig. 2), as will be described later on.

By means of the Young urological x-ray table (Figs. 3, 4, 5, 6) it is possible to make stereoscopic x-ray plates on the urological table immediately after injecting the ejaculatory ducts as shown in the accompanying illustration.

The utricle syringe is so constructed that the slender tip, which is about 1.5 cm. long, enters the duct for that distance and is then arrested by the shoulder.

This distance is apparently sufficient to carry it always into the vas deferens, as our radiographs have never shown the seminal vesicles when this instrument was used. With a shorter cannula, injections pass into the seminal vesicles.

In the progress of our work, having found it desirable to inject both ejaculatory ducts simultaneously, we devised a special forked cannula, one branch being 3 mm. longer than the other (Fig. 1-B). With this arrangement of the terminal tubes it is easy to introduce the longer tube into one duct for a distance of about 3 mm. and then be free to catheterize the other duct with the shorter tube, after which the instrument is pushed home until arrested by the junction point of the two tubes against the anterior surface of the verumontanum. With this forked cannula we have found it possible to inject 8 c.c. of thorium solution at one time and to inject both seminal vesicles.

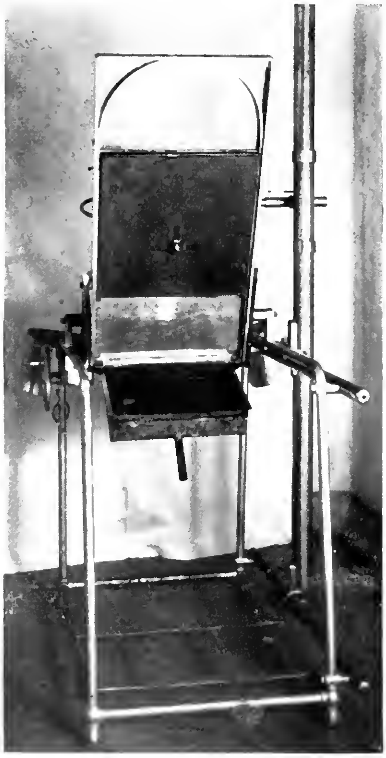


Fig. 5. Rear View of Table in Upright Position, Showing Plate Carriage in Position for Exposure.

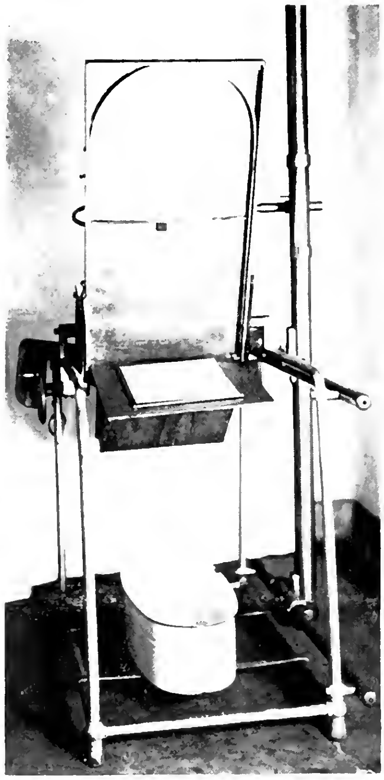


Fig. 6. Rear View of Table in Upright Position. Plate Carriage and Holder are Lowered for Reception of the Plate.

We have thus demonstrated that catheterization of the ejaculatory ducts and radiographic study of the canal system

above may be carried out with ease and furnishes a ready and satisfactory method of determining the condition of these structures. The process is apparently

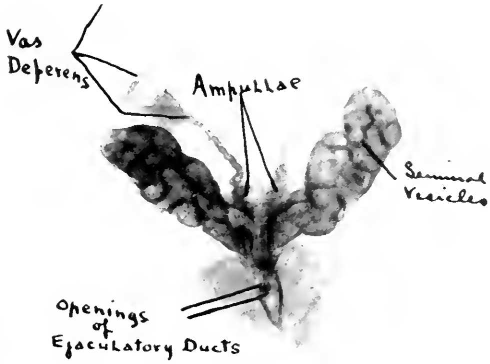


Fig. 7. Showing the Anatomical Arrangement from an X-ray Point of View.

without danger. In some fifty cases in which the instruments and thorium solution have been introduced for varying distances into the vasa deferentia and seminal vesicles, we

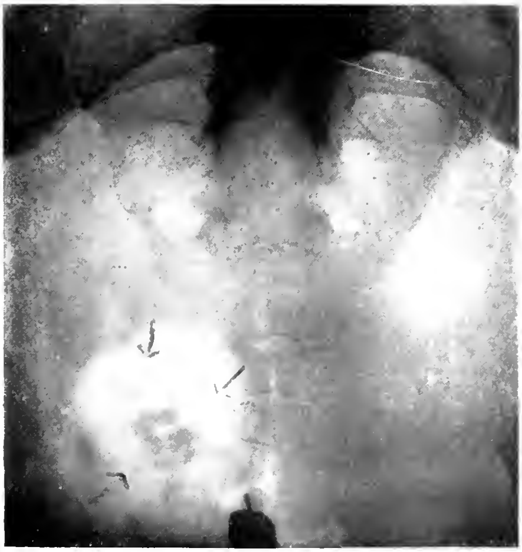


Fig. 9. Shows the Left Seminal Vesicle Partially Filled with the Convolutions and Sacculations Appearing Normal.

have never encountered an epididymitis or any other deleterious sequela.

The development of this method has been the direct outcome of the combined x-ray and urological table (Young's) by means of which it is possible to take radiographs while the patient is in a position for

Fig. 8. Diseased Vesicles and Vas Showing marked Irregularity and Distortion.

cystoscopy without disturbing him. This table makes it possible to place the patient in the horizontal, vertical, inverted and any intermediate position and to take radio-

Fig. 10. Injection with Thorium Showing the Course, Size and Convolutions of the Right Vas Deferens. The vesicles and left vas do not show in this plate. The syringe is seen in the lumen of the right ejaculatory duct. Left not yet injected.

graphs in any of these positions without disturbing the patient or the urologist.

(Note different positions of table in Figs. 3, 4, 5, 6.) The roentgenologist is able to change his plates for stereoscopy under the table with ease and dispatch, as shown in Figs. 5 and 6.

From an x-ray viewpoint, the anatomical

Fig. 11. Shows the Forked Syringe in the Lumina of the Ejaculatory Ducts before Injection was made.

Fig. 13. Drawing Made from Stereoscopic Plates Showing both Vasa Injected.

Fig. 12. Young's Method of Dilating Ejaculatory Ducts. Probe seen entering ejaculatory duct.

structures of interest in the making of vesiculograms are (1) the verumontanum with the external openings of the ejaculatory ducts; (2) the ejaculatory ducts themselves; (3) the seminal vesicles; (4) the ampullae of the vasa deferentia, and (5) the vasa deferentia above the ampullae (Fig. 7).

The following vesiculograms have been prepared from autopsy specimens with a view of showing the variations existing in the anatomical structures. The specimens have been injected with thorium through the openings of the ejaculatory ducts. The anatomy is clearly shown; the lumina of the ejaculatory ducts are plainly reproduced; while the convolutions and windings of the seminal vesicles and the ampullae of the vas deferentia are clear and distinct. Variations in the vesicles and vasa deferentia have been observed. One typical plate is shown here (Fig. 8). The vesicles are greatly enlarged; their borders are irregular and indistinct, and there is a loss of the normal sacculations and convolutions; both ampullae are markedly enlarged and irregular. The vasa above the ampullae are also seen to be dilated. The whole represents the pathological picture of an obstructive inflammatory process in the vesicles and ejaculatory ducts.

In Figs. 2 and 10 the syringe is inserted straight, first on the left side and then on the right. Only the vasa are seen. In Fig 9, the syringe is inserted at an angle and only the vesicle is seen. The explanation is that in the first instance the syringe passed by the opening of the vesicle and therefore only the vas was injected, whereas in the second instance the syringe entered the vesicle and blocked the vas so that only the vesicle was injected.

Among the conditions for which this method seems applicable and helpful for diagnosis and treatment the following may be mentioned:

1. To determine the patency of the ejaculatory duct or vas in cases of sterility when epididymo-vasotomy is contemplated.

2. To determine whether stricture of the ejaculatory duct, of the vas or of the outlet of the seminal vesicle is present.

3. To disclose the condition of the ampullae of vasa or seminal vesicles in inflammatory or tuberculous conditions.

4. To show the condition of the seminal tract in studies to determine the cause of vague pain in the region of the prostate, vesicles or bladder. Other uses of this method will be forthcoming.

Bibliography

1. Fuller. *J. Am. M. Assn.*, Nov. 30, 1912, p. 1961.
2. Picker. *XIV Internat. Med. Cong.*, Lond., 1913; 1911, read before the Third Congress of the German Urologic Society.
3. Luys. Traité de cystoscopie et d'urethroscopie. Paris, 1914, Octave Doin et Fils, Editeurs.
4. Belfield. *Surg. Gynec. & Obst.*, XVI, 1913, 596.
5. Thomas and Pancoast. *Ann. of Surg.*, LX, 1914, 313.
6. Milstone, H. J. Seminal Vesiculography. *Wisconsin M. J.*, 1918, Vol. XVII, No. 1, 146.

DISCUSSION

Dr. W. H. Manges.—This is something new and, it seems to me, something extremely important as a field of study. I don't know that any of the specialists have more difficulty in making a differential diagnosis than do the urologists, and their particular field of work in the diagnosis of purulent changes is a most important one. I may illustrate it by saying that a diseased kidney pelvis recognized early is comparatively easily dealt with, whereas if it exists for a considerable period of time, it becomes a menace to life. And so in this work there are no doubt many instances in which a good deal of mental anguish and that sort of thing could be allayed if it were known that some lesion or some anatomical condition or some process in the region of the seminal vesicles were responsible for instance for the lack of procreation. So that I think this is really an interesting and important field for study. Those of you who have worked with urologists, cystoscopists and endoscopists realize what it means to work with an expert. I have worked with both experts and beginners. I am inclined to believe from my former experience that this particular work is one which the expert must do until he has trained assistants to do it for him. In other words, the technique is a most difficult proposition from the urologist's viewpoint.

The history of the progress of our work shows us very clearly that we have as a specialty always come up to meet the necessary requirements. Our technique in the beginning may be a little bit unsatisfactory, but out of the more or less indistinct results we have, as a rule, developed into a point of accuracy, and I can think of nothing more appropriate to illustrate this point than to recall some of the incidents in the life of our late Dr. Leonard. Those of us who knew him well, remember how enthusiastic he was about being able to show the shadows of kidney stones at a time when our exposures were necessarily quite long. Leonard did see kidney stone shadows where no one else could; and so we can in injections of such small cavities as these see the outlines if we know how to study them and find them. It is a difficult technique from our point of view, and, of course, anything in the way of suggestions to improve it are entirely in order. It has occurred to me that here would be an especially opportune time to call in the assistance of the air or oxygen by injecting the bladder perhaps after the little instrument has been placed in the opening of the duct to inject the bladder with air or oxygen. It would remove so much of the soft parts in that region that the shadows of the seminal vesicles and ejaculatory duct would stand out clearly with even a small amount of solution. I am sure when you come to hear Dr. Stewart's paper and see his slides, you will recognize the advantage of displacing surrounding organs by oxygen or air.

I think we are to be congratulated in receiving this presentation and I hope Dr. Waters will continue to develop this line of work in such a way that the rest of us can do it also.

Dr. W. H. Stewart.—I would like to ask Dr. Waters if they have found it necessary to retain the instrument in site after the injection of the thorium. If it can be removed and the thorium still retained in the vesicles, it would be an easy matter to inject air into the bladder. As Doctor Manges stated, a much sharper contrast in the shadows would be obtained.

Certainly the author is to be congratulated upon this advanced work. I believe he will be able, at the next meeting, to give us more information in regard to the patholotical conditions revealed.

Dr. Charles A. Waters.—Dr. Manges' suggestion about injecting the bladder with air prior to the injection of the seminal vesicles is indeed a good idea. We have not tried it but we will as soon as I get home. The injection of the ejaculatory ducts is a comparatively simple procedure once the ducts are located. However, in many instances it requires a tedius and persistent searching to locate their openings. This work is in an elementary stage, but we have shown that it can be done and without harmful effects.

Answering Dr. Stewart's question about holding the cannula in position while the injection is being made, I might say that using the Geraghty's utricle syringe with the tip inserted up to the ampulla of the vas—a distance of 1.5 cm.—we keep the syringe in position. When we do this we should get the vasa deferentia injected because the thorium goes on past the vesicles; while in order to inject the seminal vesicles it is necessary to insert the tip of the syringe a shorter distance. In using the shorter forked arm cannula it is necessary to keep the cannula in position for both injections.

ROENTGEN DIAGNOSIS OF PATENT DUCTUS ARTERIOSUS; WITH REPORT OF A CASE COMPLICATED BY PRESENCE OF SACCULAR ANEURYSM*

BY MAXIMILIAN JOHN HUBENY, M.D.

Consulting Roentgenologist to Henrotin Hospital, Chicago Policlinic, Post Graduate School and Hospital, Grant Hospital, Chicago Municipal Tuberculosis Sanitarium.

CHICAGO, ILL.

ZINN[1] was the first in 1898 to make an *x*-ray study of the condition in patent ductus arteriosus. He showed that the normal shadow of the heart is modified as follows: The middle area of the left border of the heart shadow is much enlarged, so that in extreme cases a ball-like prominence here surmounts the heart. The position and pulsation phase of this show it to be that of the pulmonary artery. Moreover, whereas the normal pulmonary artery beats but slightly and with less vigor than the aorta, in cases of persistent ductus Botalli the pulmonary artery pulsates more powerfully than its neighbor. On watching this shadow one gets the impression that with each systole the pulmonary artery is actively distended by an increased volume of blood. The observations of Zinn have since been verified by De La Camp,[10] Hochsinger,[11] Bittorf,[12] Groedel [13] and many others.

The enlargement of the pulmonary artery is logically explained by the influx of blood into it from two sources, i.e., the right ventricle and the ductus arteriosus.

Arnheim [2] reported a case in which a diagnosis of patent ductus arteriosus was made based particularly on the *x*-ray showing a much enlarged pulmonary artery. This case, however, on autopsy proved to be a case of extreme pulmonic stenosis. No mention is made in Arnheim's report of fluoroscopic observation of the action of the heart; if this had been done it is probable that the diagnostic error would not have occurred, for it would have been observed that with each systole the pulmonary artery pulsated more actively than it does under normal conditions, manifesting considerable distension as well.

Wessler and Bass [4] state that the symptoms of patent ductus Botalli are:

(a) According to Vierort: systolic murmur over pulmonary area; hypertrophy of right side of heart; accentuated second pulmonary sound.

(b) According to Gibson: long thrill following apical impulse; the peculiar murmur.

(c) According to Hochsinger, who has made a thorough study of the condition: palpable and much accentuated second pulmonic sound; Gerhard's sign, i.e., band of dullness along the left border of the sternum in the three upper interspaces; thrill felt in the jugulum; enlarged pulmonary artery in the *x*-ray plate; murmur in second left intercostal space usually systolic in infancy, but may be diastolic as pulmonary artery develops.

(d) According to Carpenter, the thrill is not always present, the heart is not enlarged to the right and the second pulmonic sound is always essential.

(e) According to Groedel, the persistent ductus Botalli gives the most typical roentgen picture of all congenital heart affections. There is distention and pulsation of the pulmonary artery and enlargement of the right ventricle.

The authors report five cases. In two of these, radiograms were made and showed a distinctly prominent shadow in the region of the pulmonary artery. In each plate the bulging of the pulmonary artery was evident. On fluoroscopic examination the pulsation of this pulmonic shadow was the dominating feature. The heart in each case showed enlargement. Study of the orthodiagrams showed that in patent ductus

*Read at Twentieth Annual Meeting of THE AMERICAN ROENTGEN RAY SOCIETY, Saratoga Springs, N. Y., Sept. 3-6, 1919.

arteriosus, enlargement of the heart or alterations in its shape may be expected.

The lesion with which patent ductus may be confounded is most usually pulmonary stenosis. According to Hochsinger the diagnosis of patent ductus should not be made in the absence of a much accentuated second pulmonary sound—a second sound if only normal in intensity is more likely to proceed from pulmonary stenosis.

Goodman [3] studied 34 reported cases in which the diagnosis was confirmed by autopsy. Analysis showed him that there was no one particular sign which could be considered as pathognomonic, but that the diagnosis must rest upon the concurrence of a number of signs.

In a case reported by Griffith [5] the radiogram showed that there was a distinct widening of the supracardiac area of opacity referable to the great vessels. This extended further to the right than usual. A well-marked extension of the opaque area passed upward and to the left and presented very distinct pulsation. It was clearly this which caused the systolic elevation of the inner end of the clavicle. Fluoroscopic examination showed the phenomena better than the radiogram.

Hamilton and Abbot [6] reported a case of patent ductus arteriosus with acute infective pulmonary endarteritis. Manges' [9] case was quite similar. In both the usual *x*-ray findings were present.

Miller and Orton [7] reported a case in which the physical sign of patent ductus arteriosus was verified by the radiogram. They refer to the fact that the radiograms in cases of patent ductus arteriosus and aneurismal pulmonary artery may be identical, but that in the latter lesion with a closed ductus no episternal notch pulsation will be detected.

From the foregoing data there seems to be considerable unanimity of opinion as regards the value of fluoroscopic examination in the determination of patent ductus Botalli—namely, that it is important chiefly as confirmatory evidence in the presence of the other characteristic signs. The increased cardiac shadow to the left, the so called *x*-ray cap, caused by the dilated pulmonary artery, furnishes valuable evidence of patency when associated with a systolic murmur in the pulmonic area propagated with greater or less distinctness over the apex of the left lung into the upper portion of the interscapular region.

The occurrence of patent ductus Botalli is more frequent than formerly supposed. In the writer's experience, nine cases have been encountered in which the physical findings and fluoroscopic findings concurred, although only three cases came to autopsy, including the patient cited in this paper, which was referred by Dr. Robert H. Babcock. History is appended.

Mrs. C. was first seen in the summer of 1896 when she was approximately thirty-six years of age. She sought advice on account of attacks of palpitation accompanied by præcordial pain and fear of death. Her family history was unimportant and even in the personal history nothing at first was elicited that seemed of special import. She was the mother of two healthy children and in earlier life had been active in giving public entertainments without any consciousness of cardiac symptoms. It was learned subsequently that her married life was very unhappy and that her attacks were synchronous with, or soon followed her discovery of, certain marital shortcomings. Aside from these hysterical manifestations, as they seemed to be, the patient admitted only some shortness of breath on unwonted exertion. It may be stated in passing, however, that dyspnoea of effort subsequently developed to a very marked degree and coincided with the recognition and growth of the aneurysm as years went on.

Upon physical examination and for several years following the first examination the findings were as follows: The apex beat was inside the left mammilary line and was preceded by a very short slight thrill, while at the left of the sternum in the second interspace was a peculiar pronounced purring thrill which was unintermitting but with a rhythmic diminution and increase of in-

tensity not sychronous with either systole or diastole. Præcordial dullness was only slightly increased transversely, and on auscultation the chief and very striking feature was a continuous diminuendo and crescendo murmur which nearly or quite replaced the two pulmonic tones. The first sound at the apex was roughened and the aortic second tone was moderately accentuated. The urine was negative and blood examination showed a moderate chlorosis. The lungs and abdomen were negative.

As years passed there gradually appeared an area of dullness at the right of the sternum corresponding with the position of the aortic aneurysm, and at length the singular bruit of remitting intensity gave place to a systolic murmur audible also at the right of the sternum and succeeded by a sharply accented second tone. At this time dyspnoea of effort was pronounced and the

Fig. 1. Case of Patent Ductus Arteriosus Complicated with Specific Aortitis and Aneurism, also by Marked Cardiac Hypertrophy. Arrow-heads show prominence of the pulmonary artery on which the fluoroscopic examination demonstrated vigorous pulsation.

symptoms were plainly due to pressure by the aneurysm. Finally also gastic crises developed, the nature of which was not recognized,as the existence of lues was never even suspected. There were none of the ordinary stigmata of syphilis and the patient passed through several operations and illnesses without complications and with no more difficulty than would a person free from lues.

Without desiring to excuse the failure to recognize the syphilitic nature of the aortic dilatation, it may yet be stated that in the absence of a specific history and of glandular or other signs of lues, and owing to the fact that Wassermann examinations were seldom made fifteen to twenty years ago, an explanation for the development of aortic dilatation was sought in the possibility of some anomaly which was responsible for the persistence of the ductus arteriosus. It was conjectured that the aorta was narrowed at some point beyond the opening of the duct, and yet there was no appreciable difference in the size of the peripheral vessels in the upper part of the body as contrasted with those of the lower extremities.

Death resulted from sudden rupture of the sac and postmortem examination of the heart and aorta showed the aneurysm to be due without doubt to syphilis.

In this case the original findings corresponded with those described by Gibson and Babcock as characteristic of patency of Botalli's duct, while the symptoms were not those of cardiac incompetence but were neurotic until at length pressure phenomena dominated the scene.

Roentgenologic examination of this case was unfortunately not made until after the aorta had become greatly dilated. It then showed changes due chiefly to the presence and effects of the aneurysm.

There was great cardiac enlargement associated with a corresponding increase in the size of the aorta, which on fluoroscopic examination revealed a saccular aneurysm on the ascending aorta pointing to the right and downward; the pulmonic area was enlarged and showed a marked systolic pulsation.

The anatomic diagnosis made by Dr.

Caylor showed: (1) A spontaneous rupture at the saccular aneurysm of the first part of the aorta. (2) Syphilis of the aorta. (3) Sclerosis of front mitral and left pulmonary leaflets. (4) Slight sclerosis (syphilitic) of the lining of the pulmonary artery. (5) Fatty infiltration of the myocardium. (6) Hypertrophy of the walls of the left ventricle. (7) Dilatation of the left auricle. (8) Fibrous adhesions between the right auricle and base of the aorta. (9) Patent ductus arteriosus. (10) Accessory opening of the right coronary artery.

References

1. Zinn, W. Zur Diagnose d. Persistenz des Ductus Arteriosus Botalli. *Berl. klin. Wchnschr.*, 1898, xxxv, 433.
2. Arnheim. Persistenz d. Ductus Botalli. *Berl. klin. Wchnschr.*, 1903, xl, 616.
3. Goodman. Patent Ductus Arteriosus Botalli. *Univ. of Penna. Med. Bull.*, 1910-11, xxiii, 509.
4. Wessler, H. and Bass, M. H. (N. Y.) Persistent Ductus Botalli and its Diagnosis by the Orthodiograph. *Amer. J. of the Med. Sc.*, 1913, cxlv, 543.
5. Griffiths. *Quart. J. of Med.*, Oxford, 1915, viii, 191.
6. Hamilton and Abbott. *Tr. Assn. Am. Physicians*, 1914, xxix, 294.
7. Miller and Orton. A Case of Patent Ductus Arteriosus with Skiagram. *Brit. J. of Child. Dis.*, 1913, x, 109.
8. Stoddard, J. L. A Case of Open Ductus Arteriosus (Botalli) with Necropsy. *Arch. Int. Med.*, Chicago, 1915, xvi, 38.
9. Manges. Infectious Endarteritis Occurring with Patent Ductus Arteriosus. *New York Med. J.*, 1916, civ, 581.
10. De La Camp. Diagnose d. Persistenz des Ductus Arteriosus Botalli. *Berl. klin. Echn.*, 1903, xl, 48.
11. Hochsinger. Zur Diagnose der Persistenz des Botallischen Ganges. *Weiner Klin.*, 1907, xxxiii, 311.
12. Bittorf. Ein Fall von offener Ductus Botalli. *Muench Med. Wchnschr.*, 1903, i, 1771.
13. Groedel. *Deut. Arch. f. klin. Med.*, 1911, ciii, 413.

X-RAY WORK IN THE CANADIAN EXPEDITIONARY FORCE*

BY LIEUT. COL. ROBERT WILSON

Consultant C. A. M. C.

TORONTO, CANADA

The study of the beginning of things is always interesting. The South African War of 1902-4 served to show the possibilities of *x*-ray work, but the high tension transformer had not yet been thought of, and the apparatus with coils and mechanical vibrating interrupters of the "Vril" type, with Neef hammer, and ranging from 6 in. to 9 in. spark gap were the only things available.

The nature of that war, with the greater mortality resulting from disease than from bullets, and of a more or less guerilla character, combined with the comparatively small size of the Expeditionary Force, all militated against the evolution of any very efficient type of *x*-ray unit. Among the lessons learned from that war, however, was the necessity for the reorganization of our medical services, and attention was drawn to the importance of the then new science of radiography. Its possibilities were realized more as an academic than as an actual and serious problem.

The attitude of the medical profession towards radiography at that time must also be taken into consideration. Its value was realized, but it was regarded more as a rather expensive luxury to be utilized as a last resort in difficult and obscure cases than as a routine aid to the surgeon or physician in diagnosis.

Between the end of the South African war and the onset of the Great war in August, 1914, the enormous advantage of radiography as an aid to diagnosis in civil practice had been realized; at its outbreak the necessity of furnishing the various military hospitals with an efficient *x*-ray equipment became urgent.

As far as I have been able to find out there was at that time in the Canadian Army Medical Service no one specially qualified to advise in this matter, nor was there in

*Read at Twentieth Annual Meeting of The American Roentgen Ray Society, Saratoga Springs, N. Y., Sept. 3–6, 1919.

Canada at that time (or is there even now, for that matter,) any firm manufacturing x-ray apparatus. Several equipments were bought from American firms, mostly of the coil type, and in view of our present powerful installations it is interesting to look back on the little 1½ horse power petrol engines driving the small 250 watt direct current generator which in turn supplied the 9 in. coil. These were for the stationary hospitals of 260 beds. For the general hospitals of 520 beds a slightly larger equipment of about 3½ horse power supplying a 12 in. coil through a Wehnelt interrupter was provided, and I well remember the surprise and indignation of a high military officer on being told that three 7 in gas tubes were altogether inadequate for the service that might be required.

The developing was supposed to be done in a small developing box of the type where one sticks one's hands through a pair of light-proof sleeves, manipulates the plates by sense of touch and watches the process through a small piece of ruby glass. It is easy to be wise after the event.

Another type of machine furnished consisted of the petrol motor and direct-coupled alternator with a high tension transformer in a separate box, with cumbrous wires leading from the generator to the transformer, back to a rectifying disc made of red fiber, which either warped very rapidly, or shorted and burned!

In view of the comparatively powerful installations available at that time they were puerile. Evidently the nature of the country and density of population over which battles would have to be fought was not reckoned with, and everything seemed to be sacrificed to portability.

Even with such inadequate apparatus, the shortage of shipping was so acute that it was not until December, 1914, that this apparatus reached us in England, although the First Contingent sailed from Canada in September of that year.

We were momentarily expecting to be sent over to France, and so permission was sought and obtained to purchase equipment in England. Here our difficulties commenced, because the high tension transformer, while not unknown, was very scarce in England. Moreover, facilities for the manufacture of high tension rectifying devices did not exist, and so a compromise was effected: when designed, a motor generator set of 15 h. p., direct coupled to a 12 k. w. direct current 200 volt generator used, with a specially wound low ratio 20 in. coil with a mercury-jet interrupter.

The equipment as finally furnished was practically that which I had submitted to the authorities at Valcartier Camp, Canada, shortly before sailing in September, 1914. The size of this equipment was a little staggering to the imperial authorities in France, and the space required was only obtained with greatest difficulty.

The first Canadian hospital to reach France was No. 2 Stationary and this had to be satisfied with the equipment which reached us some time in January from Canada. The second one to go over was No. 1 General, to which I was attached, and this one took over the large installation above mentioned.

With the exception of administration buildings and operating block this hospital was all under canvas. By the time the tents were up a small engine room 10 feet square had been built of frame and corrugated iron to house the generating set. There were, however, no electric lights in the camp, although it was wired, and so for six weeks during the day we used the current for the x-ray, and during the night we were using separate feed wires which supplied 250 lights to the hospital.

Looking back at the installations as they existed in the early days of the war, compared with those which now equip our military hospitals in Canada, one wonders not so much that the equipment was then so deficient, as that a small nation such as ours, struggling to equip five contingents, succeeded as well as it did. I would remind you that culpability exists not for making mistakes, but for persisting in making them.

It is interesting to note that the first

Coolidge tubes seen on the fields of France were those supplied with our General Hospital equipments; some idea of the capacity of a suitably wound low ratio 20 in. coil working with a mercury interrupter of proper capacity may be gained by knowing that with a 5 in. spark gap 50 milliamperes of current could be passed through a Coolidge tube. As a rule, however, the low amperage technique was adopted. There rarely were more than 12 milliamperes used, with a 6 in. equivalent gap.

Towards the second year of the onset of the war it was realized that clearing hospitals were capable of doing a certain amount of urgent surgical work and x-ray equipments were sent to them.

With the advent of two more General Hospitals, the x-ray situation became very complicated, as in the absence of any military x-ray department in Canada, these hospitals had out of their funds provided themselves with more modern apparatus. However, the fact remains that in my opinion the finest work done by our Canadian x-ray departments in France was that of No. 2 General Hospital provided with the equipment manufactured in England of which I have already spoken.

System and Records.—The system of recording adopted was that of a printed requisition with the necessary information filled in and a space for a brief report to go back with the patient. For statistical purposes a system of special index cards was adopted, each with a small projecting tab. The human body having been divided into 10 arbitrary divisions, each tab was suitably labelled, and on the patient being radiographed and recorded, the necessary particulars were entered upon the card corresponding to the part of the body radiographed. These were further subdivided by alphabetical indices so that in looking up the record of any particular cases much time was saved.

Each x-ray department was provided with a 5 by 7 inch ordinary photographic camera and a kit for taking lantern slide plates. It was originally the intention that lantern slides should be taken of all plates suitably identified and used for record purposes in connection with pensions. This was never fully carried out, however, owing to the tremendous rush of work. Still, quite a number of slides were made of important and unusual lesions. Printing paper was also provided and where possible a print of the lesion was sent with the patient, but this I fear was more honored in the breach than in the observance. I am quite sure that should the harbor at Boulogne ever be the scene of archaelogical research in the approaching centuries, the tons of x-ray negatives unearthed will be a source of much conjecture! Rarely did a negative sent with a patient get nearer England than that same harbor bottom, and who are we to decide the relative value of souvenirs and x-ray negatives to the soldier?

With the admission occasionally into the hospital of 500 or 600 casualties at a time, and the subsequent rush next day to evacuate to the Base in England, it was very often physically impossible to do more than decide which cases should go and which should remain. Very often plates were sent with the patient only to be lost in transit. Towards the end of the second year, x-ray negatives began to accumulate in large numbers; and rather than lose so much scientifically valuable material it was decided to ship these plates to the Granville Canadian Special Hospital in England, where a photographic Department existed with facilities for making slides. Unfortunately, very often the negatives arrived indifferently packed, occasionally smashed beyond recognition and frequently with the index cards lost. Even under this difficulty, however, sufficient material has been saved to have made the effort worth while, and in the Army Medical Museum in Ottawa the scattered remnants are being gradually assembled.

Equipment of Base Hospitals in Canada.—With the institution of base hospitals in Canada definite plans of x-ray departments were laid down, as well as an adequate equipment list. Here every effort was made to use the most modern installation available,

and a glance at the equipment list will, I think, show the thoroughness with which this has been carried out. The installation is the equal of that of any well-equipped civilian general hospital, and the very large use made of it by the recruiting stations for chest and heart examinations, and by the Pensions Boards, testifies to its usefulness.

Of the general work on the field there is not much that can be said which is not already familiar. Those who came later had the benefit of our mistakes, and the advantage of a large number of highly trained medical radiographers.

It was our routine practice to examine all cases coming into hospital first by the screen and then by plates. The vexed question of localization will not be discussed here. Like the making of books, of the devising of localization systems there seems no end. For plate work, as for screening, the triangular method is the basic one. Where practicable and where the number of foreign bodies was not too great, the double axis method was very useful, while for extremity work and for rough localization the parallax method was *very* useful. For complicated work, however, or for brain surgery, or for spinal work or abdomenal work, the compass of Hirtz is without question the most accurate means, but exceedingly cumberous and time consuming.

With the exception of one of our Hospitals (No. 8 at St. Cloud near Paris) this method was not adopted; but localization by the 10 centimeter shift, using a definite anode plate distance and a prepared scale known as the Milnergraph, was found to be sufficiently accurate for all purposes. The whole question of localization, however, like everything else in *x*-ray work, depends largely upon the personality of the operator; and attention to the thousand and one little details with which all *x*-ray men are familiar made for accuracy, just as the neglect of any of them resulted in inaccuracy.

The time is too early yet to tabulate our results and draw conclusions. It is at this time impossible to give any accurate incidence or percentage of lesions.

Of the use of the *x*-ray for purposes other than that of localization of foreign bodies, or bone lesions, there is not much to say. In England our general hospitals utilized it to a certain extent for the treatment of cicatrices, fibrosis and for an occasional skin lesion. Some experiments were carried out for the treatment of large surface wounds, but not to any very large extent.

Protection.—The question of adequate protection very early came before us. We found that many of the British equipments were very poorly protected. The matter was finally taken up by the London X-ray Society and a definite standard of protection, for rubber, glass and thickness of lead, decided upon.

The difficulties in the manufacture of suitable glass in England were almost insurmountable, and dependence had to be placed upon suitable lead rubber, and sheet lead. The number of cases of dermatitis in our own Canadian units were exceedingly small —in fact I only know of one case among radiographers which developed any serious dermatitis and that only in the hands; I never saw a patient burned, and I never saw or heard of a patient who had been burned.

Perhaps quite the most extraordinary thing I came across was the case of a man admitted to No. 1 General Hospital, Étaples, with a fractured right jaw, with no visible external wound except a slight cut on the inner side of the lip; he was brought to be radiographed for this and for pneumonia. Careful physical examination failed to show any reason for the fracture or the pneumonia until the persistence of a large shadow under the right clavicle led to a more careful examination, when a piece of metal 2¾ in. long, roughly ⅝ in. wide and not quite a ¼ in. thick was located. The man died of his pneumonia and a postmortem examination showed a piece of high explosive shell case of the dimensions given situated directly under the right clavicle and finally lodging in the position found. How a piece this size could get down from the small wound and do the damage it did to the jaw without any injury to the vital struc-

tures in its path, and without any surface [illegible] beyond the wound of entry is a mystery.

GENERAL REMARKS

With the end of the war and the demobilization of the forces the question of the future of our specialty takes on a new and important aspect.

Of less importance perhaps is the comparatively large number of men who have taken up the work seriously and decided to make it more or less their life work; of greater importance is the impetus given to it by the demonstrated indispensability of accurate and skilled *x*-ray work, coupled with the special knowledge which comes only with time. Every medical man in whatsoever capacity, has learned to depend on the *x*-ray findings. He is going to carry that dependence into his civil practice. Is he going to utilize a picture made by a technician and make his own diagnosis, or is he going to send his work to a medical man skilled in *x*-ray work?

I want to warn you that you are at the parting of the ways. Apparatus has reached a stage of development where technique is practically fixed, and dependable results in valuable diagnosis will be regulated by the special knowledge of a qualified medical graduate.

May I point out to you that there is a great difference between adopting business *methods* into our profession and commercializing a technique: that a technician is a valuable adjunct to a medical radiographer, but that he should have no place in establishing so-called laboratories. In fine, our art should be part of a university curriculum, and I am glad to note that Cambridge has set the pace by establishing a special course qualifying for a degree somewhat analogous to the Doctorate of Public Health.

RADIOTHERAPY OF UTERINE FIBROMYOMATA. RESULTS, MODE OF ACTION AND INDICATIONS, BASED ON THE STUDY OF 400 PERSONAL OBSERVATIONS*

BY DR. A. BÉCLÈRE

Physician to the Hospital Saint-Antoine. Member of the Academy of Medicine

PARIS, FRANCE

Translated by Isaac Gerber, M.D.

THE present communication is the result and the complement of one which I made at London, in August, 1913, at the Twenty-seventh International Congress of Medicine, before the combined sections of gynecology and radiology. At that time, I presented the statistics of the sixty cases of uterine fibroids that I had treated with *x*-rays in my own private practice from 1908 on, and whose course I had followed much more closely and over a greater period of time than is possible with hospital patients.

To-day the total number of cases of this same condition which I have been able to collect amounts to almost five hundred, but the most recent ones have not yet undergone the test of time. The study which I am presenting now is therefore based entirely upon the first four hundred cases of fibroids that I have had the opportunity of treating, and includes the cases previously reported at London.

This report will cover three aspects of the problem: the facts observed; their interpretation from the point of view of the

*Communication at the First Congress of the Association of Gynecologists and Obstetricians of French tongue, Brussels, Sept. 27, 1919.

mode of action of the roentgen rays, which is still a matter of dispute; and the practical indications which follow.

CONDITIONS AND RESULTS OF THE TREATMENT

Since it is impossible to report four hundred cases in detail, I shall briefly summarize the ages of the patients treated, the size of the uterine tumors, the complicating functional disturbances, the technique and duration of the treatment, its dangers, and its action upon metrorrhagias and on the size of the fibroids.

Age of the Patients Treated.—From the viewpoint of age, the 400 cases observed can be divided as follows:

From 55 to 56 years	9	cases
" 50 " 54 "	89	"
" 45 " 49 "	130	"
" 40 " 44 "	126	"
" 35 " 39 "	31	"
" 30 " 34 "	15	"

The percentages of the total were as follows:

Patients of 50 years and above	24.5%
" " 40 to 49 years	64 %
" " 30 to 39 years	11.5%

Dimensions of the Fibromatous Uterus.—From the point of view of situation, dimensions, and size, the 400 uteri treated may be divided into two groups according to whether they escaped or were accessible to abdominal palpation.

The first group, that of the uterus which vaginal examination showed to be more or less enlarged, deformed and lobulated, but which did not rise above the level of the symphysis pubis, comprises only 62 cases.

The second group, which is much more important both in numbers and in the interest of the observations, comprises the other 338 cases. This group is characterized by the fact that the uterine tumor, accessible to abdominal palpation (either alone or combined with vaginal examination), projects more or less above the level of the symphysis pubis.

The percentages of the two groups are as follows:

Intra-pelvic fibroids	15.5%
Fibroids with abdominal projection	84.5%

In order to estimate the volume of uterine tumors, certain precise measurements are preferable to the loose comparisons ordinarily used. When the tumor is palpable, it is easy to measure with sufficient exactness the distance in centimeters of its upper pole from the pubic symphysis. Also the transverse diameter may be measured, and, in some cases of abnormally prominent abdomen, the anteroposterior dimensions may be measured. It is important in making these measurements that the patient should lie in the dorsal decubitus, on a perfectly horizontal plane. Another necessary precaution is to make certain that the bladder has been emptied before the examination.

In the 338 cases where the tumors were palpable, measurements were made according to these conditions. Before treatment, the superior pole of the uterine tumor rose above the symphysis pubis to the following extent:

from 25 to 30 cm. in	9 patients, or	2.66%	of all cases
" 20 " 24 " "	25 " "	7.39%	"
" 15 " 19 " "	51 " "	15.08%	"
" 10 " 14 " "	111 " "	32.84%	"
" 5 " 9 " "	104 " "	30.76%	"
" 1 " 4 " "	38 " "	11.29%	"

Complicating Functional Disturbances.—In the great majority of the patients, the predominating symptom consisted of metrorrhagia, more or less copious, more or less prolonged, and more or less regular in its appearance. In a few of the cases, the severe loss of blood had required packing several times. Many patients were gravely anemic, and in several instances the hemoglobin value had fallen to as low as 50 per cent.

On the other hand, in a fairly large number, the menses had maintained their usual amount, or were only slightly increased. The other chief reasons for which the cases came to treatment were abnormal size of the uterine tumor, very apparent abdominal distension, rapid growth of the tumor, and compression upon neighboring organs, especially upon the bladder. In several of the latter cases catheterization had been necessary several times.

Technique and Duration of the Treatment.—From the point of view of technique, the method which I have always employed is that of giving weekly treatments, which necessarily implies the use of moderate doses. For many reasons, I prefer this to the method of monthly intensive doses, which has been especially advocated in Germany, and also in my own country by a certain number of radiotherapeutists.

Each weekly treatment consists essentially of two successive exposures, one to the right and the other to the left of the median line of the abdomen, just above the horizontal ramus of the pubis. Occasionally, when the uterus is retroflexed, or when the fibroid occupies the concavity of the sacrum or the cervix of the uterus, a third exposure is directed towards the sacral region. Also if the dimensions of the tumor require it, the surface of the abdomen is divided not only into two, but into three, four or even six areas, and each in turn serves as the portal of entry for the rays. Each exposure is localized on a circular surface, 10 centimeters in diameter, by means of a cylinder of lead glass, which is opaque to the *x*-rays. A small disk of wood is placed between the localizing cylinder and the abdominal wall. This depresses the abdomen, flattens its surface, and by means of gentle compression enables us to lessen the distance which separates the ovaries from the skin. The target of the tube is set, according to the size of tube used, from 18 to 22 centimeters (7.2 to 8.8 inches) above the exposed surface. The tube which I used in almost all of the cases was a Thurneyssen tube, with the osmo-regulator of Villard, and an anticathode of platinum or iridium. It allowed the passage of 1 milliampere of current. At the present time, it is replaced by a Coolidge tube, with a current of the same tension, but with three milliamperes, so that the dose can be given in one-third the time. With this new tube, each exposure lasts a maximum of five minutes, instead of the previous duration of ten or fifteen minutes.

In two particulars only have I modified my earlier technique. For a long time now I have used a sheet of aluminum through which the rays are filtered. At first I used 1 to 2 mm.; later 2 to 3 mm.; at present I employ a filter of 5 mm. I have also increased the penetration of the rays, as measured by aid of the spintermeter, so that it has been raised from an equivalent spark-gap of 15 to 20 cm. (6 to 8 inches).

As for the dosage, measured by the Sabouraud-Noire pastille after the passage of the rays through the filter, it usually did not exceed 3 Holzknecht units at each exposure and for each of the areas treated, and reached a maximum of only 3½ units.

In the cases studied the treatment necessitated

From	4	to	11	treatments	in	38	Patients
"	12	"	14	"	"	202	"
"	15	"	20	"	"	109	"
"	21	"	30	"	"	45	"
"	31	"	50	"	"	6	"

Thus in 60 per cent of the cases the treatment did not last more than from two and a half to three months, and did not require more than from 12 to 14 weekly treatments.

Dangers of the Treatment.—The only real danger in radiotherapy is an excess of dose, which provokes cutaneous reactions in the form of acute radiodermatitis or of late trophic lesions. All the other dangers that the treatment is accused of are imaginary. The danger of cutaneous lesions can be avoided by a good technique and a certain amount of experience. Only twice have I produced a late ulceration of the abdominal wall, arising in one case four years, and in the other seven years, after the cessation of treatment. These cases were in the early days of radiotherapy of fibroids, being the first and the third of the cases which I treated, when I did not as yet employ a filter of sufficient thickness. A cure was obtained in the first case only after excision of a small area of skin. The second case healed in three months with simple dressings. Since that time I have not observed any similar accidents.

Therapeutic Results—Among the therapeutic results obtained without pain, and

without any change in the usual mode of living, the two principal were the suppression of the metrorrhagia, and the reduction in size of the uterine tumors.

Action on the Metrorrhagia.—Only four times in my experience did radiotherapy fail to save the patients from surgical intervention. In these cases surgery was justified by the serious losses of blood. It seems to me, however, that to-day, with the better technique at our disposal, such cases would have been more successful under radiotherapy. In all the other cases, in addition to the disappearance of the metrorrhagia, there resulted a suppression of the menstrual function. This suppression, accompanied almost constantly by the appearance of hot flushes characteristic of the menopause, was the signal for stopping the treatments. In several cases, before their disappearance the menses became more abundant. Omitting those cases in which the bloody flow was continuous, or so irregular as not to permit differentiation from the true menstrual hemorrage, the following is a list of the number of times that the menses appeared after starting treatment, until they became suppressed. The menopause arrived

Without any further menstruation .	in 3	patients
After the appearance of 1 period .	" 61	"
" " " " 2 periods .	" 128	"
" " " " 3 " .	" 89	"
" " " " 4 " .	" 29	"
" " " " 5 " .	" 9	"
" " " " 6 " .	" 8	"
" " " " 7 " .	" 3	"
" " " " 8 " .	" 4	"
" " " " 10 " .	" 1	"

Thus in the majority of the cases the menses were suppressed without having returned more than two or three times after beginning the treatment.

This artificial menopause generally remained permanent. In 48 patients, however, or 12 per cent of the entire number treated, it was merely temporary. After an absence of variable duration, generally several months, rarely as long as one, two or even three and a half years, the menses would reappear. A repetition of the treatments resulted in a new menopause, usually after only a small number of exposures. In 9 of the cases, after several months' interval, there was a second recurrence of menstruation, and in three patients even a third. Finally, however, after repeating the treatments, a permanent menopause was obtained in every instance.

Effect on the Uterine Tumors.—In all the patients treated without exception, the uterine tumor was not merely checked in its development, but it diminished in size. In the 62 cases of intrapelvic fibroids, this diminution in size could not be measured exactly, although often estimated roughly by the observers as being a reduction of a third, a half, or two-thirds of the original size; or even as a return of the uterus to its normal state. On the other hand, in most of the palpable uterine tumors, and at nearly every treatment, I used the previously described measurements, which were applied with the necessary precautions. In 278 cases where the results were exactly recorded, I found after each treatment that the distance of the upper pole of the fibromatous uterus from the symphysis pubis was lowered to the amount of

From 1	to 2	centimeters	in 12	patients
" 3	" 4	"	" 42	"
" 5	" 6	"	" 73	"
" 7	" 8	"	" 62	"
" 9	" 10	"	" 52	"
" 11	" 12	"	" 26	"
" 13	" 14	"	" 10	"
" 16		"	" 1	"

The reduction in the transverse dimensions was no less striking than that of the vertical dimensions. In the cases where the abdominal tumor made a very apparent abdominal projection, I also noted a material lessening in the anteroposterior diameter of the abdomen.

In this reduction of size, which is so constant, and often so marked and relatively rapid, the most interesting aspect, and the one which should always be emphasized is its evolution.

The reduction in size of the palpable uterine tumors begins with the very first

exposures of the set. It is appreciable most often after the third and sometimes after even the second treatment. From week to week, the superior pole of the tumor progressively approaches the symphysis pubis. In the more favorable cases it drops at the rate of about a centimeter each week.

This early reduction in size, which precedes the cessation of the menses by at least two or three months, is also manifest in other ways. In the cases where symptoms of compression exist, especially of the bladder, these symptoms begin to lessen from the very beginning of the treatments, and are improved gradually from week to week.

The above are the actual facts which have been observed.

MODE OF ACTION OF THE TREATMENT

According to the commonly expressed opinion, the action of the roentgen rays in the treatment of uterine fibroids is directed primarily against the ovaries. They produce essentially a "dry castration," the results of which include the regression of the fibroids, just as formerly they followed the bloody castration recommended by Hegar and Battey. The above opinion, put forth originally in Germany, is quite general in that country, from which it spread elsewhere.

In France, however, where the radiotherapy of uterine fibroids was really born in 1904 with the publication at that date of the observations of Foveau de Courmelles, there is a different opinion. A number of radiotherapeutists, including the above, and also Bordier, Laquerriere, Guilleminot, Jaugeas, Haret, Beaujard, Ledoux-Lebard, d'Halluin, and many others whose names I do not recall, have called attention to the fact that the reduction in size of the fibroids treated by the x-rays is often much more rapid and more marked than that which follows the physiological menopause.

They have especially shown that this reduction is seen long before the treatment has brought about any suppression of the menses. Wetterer of Mannheim has made the same observations. All these observers, therefore, admit a direct action of the x-rays upon the actual fibroids, in addition to the action of the rays on the ovaries.

In this connection, my own observations certainly confirms theirs. The method of weekly treatments, the careful measurements at each treatment, the abundant statistics which I have brought before you all make up a mass of proof, so abundant and exact, that it seems to me impossible henceforth to doubt the *primary and direct action of radiotherapy upon the fibroids.*

To these incontestable proofs I wish to add another, no less important. In three patients, whose fibroids began to increase in size *several years after the natural menopause,* I have seen radiotherapy produce an important reduction in size of the palpable tumors, and a lowering in height of the superior pole by several centimeters.

Finally it must be remembered that the x-ray treatment of uterine fibroids is only one of the chapters in the radiotherapy of neoplasms, although for some reasons perhaps the most important. The destruction and disappearance of the neoplastic cellular elements of which the fibromyomata are formed, constitute the chief result of this type of treatment, and the primary manifestation of its action.

It is not necessary, however, to continue the treatment to the stage where the normal cellular elements of the primitive ovarian follicles are destroyed in their turn by the action of the roentgen rays. This is what we can learn by the method of practical measurements.

After the cessation of the menses and the appearance of the hot flushes, characteristic of the menopause, if the treatments are suspended, the uterine tumor will most generally continue to descrease in size, but much more slowly than during the course of the treatment.

However if, after an absence of some duration, the menses should reappear, this return is very often accompanied by an exacerbation in the activity of the fibroid. It begins to grow again, and enlarges appreciably. From numerous observations, I have found that this increase in size pre-

cedes the return of the menses, but is itself preceded by the premature disappearance of the hot flushes. The ovary, which is a gland of internal secretion and the trophic center of the entire genital apparatus, thus manifests a stimulating action upon the development of neoplasms in the muscular wall of the uterus. This is a fact which we must seriously consider. I therefore always impress upon my patients, especially on the younger women, after the artificial menopause has been produced, not to wait until the menses return before taking up further treatments, but to come back for examination if at any time the hot flushes should prematurely disappear. In such cases, the finding of an increase in size of the uterine tumor is an indication for immediate renewal of the treatment.

INDICATIONS FOR THE TREATMENT

In the treatment of fibroids, according to whether radiotherapy is considered as a method of ovarian sterilization, or as a destructive agent acting on the neoplastic elements, its field of application would appear to be more or less strictly limited.

In the eyes of the partisans of the first opinion, the chief and almost exclusive indication for radiotherapy is the metrorrhagia caused by fibroids of small size in women over 40 years of age.

In all the other cases they would prefer removal. Only when surgery is contra-indicated for some reason, such as age, obesity, general poor condition, extreme anemia, pathology in the heart, aorta, lungs, kidneys, or liver, old or recent phlebitis, etc., do they permit radiotherapy, and in these cases merely as an uncertain experiment, and merely as a makeshift.

As a matter of fact in every case in the group which I am presenting, where surgical intervention was contra-indicated for some one of the above reasons, radiotherapy succeeded in producing a complete cure.

According to the results obtained, the scope of the indications for radiotherapy in the treatment of uterine fibroids should be greatly enlarged.

I trust that I have shown that radiotherapy has a direct action upon fibroids, arresting their development and producing a more or less complete regression; that it is as useful before 40 years of age as after; that it is just as efficacious on fibroids of great size as on those of small dimensions; also that it is useful in cases with normal menses as well as in those with metrorrhagia.

I might add that the apparatus and the technique for this mode of treatment are far from having reached their highest degree of perfection. They are continually undergoing transformation and progress. I do not overlook the fact that some observers have announced therapeutic successes obtained much more rapidly than those of the group which I have presented; in some cases in an extraordinarily shorter period of time. May we not hope that in the near future all radiotherapeutists will be able to obtain similar results.

In conclusion, I feel warranted in making the following generalization:

Outside of certain pathological conditions which demand immediate surgical intervention, radiotherapy is applicable to all uterine fibroids.

It has been only with the help of gynecologists such as Bar, Champetier de Ribes, Dalché, Labadie-Legrave, Lepage, Pinard, Ribemont-Dessaignes, Siredey and Tissier, and to surgeons such as J. L. Faure, Gosset, Perier, Ricard, Rochard, Roux (of Lausanne), and Walther, in addition to many other excellent colleagues, that I have been able to collect these statistics, and I express my thanks to all of them. Among them no one has shown me more confidence than Professor Pinard; no one has had more opportunity to verify the therapeutic results obtained; and I wish to express my particular thanks to him.

RADIATION IN INOPERABLE CASES OF CARCINOMA IN THE FEMALE GENITO-URINARY ORGANS*

BY JOHN G. CLARK, M.D., AND FLOYD E. KEENE, M.D.

PHILADELPHIA, PA.

ONE year ago we presented a summary of results in 100 cases of inoperable cancer of the cervix and female genital organs treated in the Gynecological Department of the University Hospital, and arrived at the following conclusions:

"1. As a palliative remedy, radium is the treatment par excellence in inoperable cases of cancer of the cervix.

"2. In border-line cases, in which formerly we accepted the grave risks of an operation in the hope of eradicating the disease, we now employ radium; but in the certainly operable class we still advocate a radical operation followed by post-operative radiation.

"3. In cancer of the fundus, even when far advanced, we perform a hysterectomy, resorting to radiotherapy only in the face of grave operative contra-indications."

Our fourth conclusion, which in view of our further experience, we now feel may be modified by a limited claim for actual curability, was as follows:

"4. As yet we claim no cures, but, based upon the observation of a considerable number of inoperable cases which have remained locally healed from one to three years, we venture the hope that the quinquennial test will find several survivors."

Our list now comprises 209 cases since 1913 with the following results:

	Dead	*Not traced*	*Living*
1914	8	0	1
1915	19	1	4
1916	46	8	11
1917	33	3	23
1918	5	13	34
Total	111	25	73

We regret that we are unable at this stage of our report to give a more complete summary owing to the fact that the number of patients not traced is accounted for by two conditions incident to war; first, the decreased number of our hospital staff, rendering it impossible to keep our follow-up system up to date,—and second, the nomadic tendency of an urban population, due to the recent fluctation of our industrial system and the disturbance incident to the housing situation. In endeavoring to trace our patients we have not infrequently found a change of three or more addresses within a few months after their discharge from the hospital. Notwithstanding such omissions in our reports, the showing in this series is rather remarkable, and we have been greatly encouraged to find so large a number of patients, all of whom fell within the inoperable class, still living and apparently well many months subsequent to their last treatment. A number of these cures have been startling; we believe we are justified in our hopes for some permanent cures, and we know beyond cavil that the palliative results have been far and away better than those following any therapeutic measures hitherto employed. In reviewing our results from radium therapy, we find that same bizarre tendency as noted in our previous surgical experience with cancer. From the appearance or even the extent of the disease no one can forecast with assurance the probable outcome of treatment.

When surgical measures are invoked, one frequently ends an operation with a great degree of optimism as to a cure, because the disease has apparently been well circumscribed and has shown no demonstrable metastasis, and yet within a few months it has again appeared with renewed violence at the local site of operation, while in another case, when the frontier zone of the growth has not been satisfactorily encom-

*Read at the Third Annual Meeting of the American Radium Society, Atlantic City, N. J., June 5, 1919.

passed and the prognosis is bad, the patient may remain free a long time from recurrence or may even be cured. This same peculiarity has been noted in our radium experience. Thus in our 9 cases treated in 1914, the one living patient discredited every forecast and survives to-day, and is to all appearances cured despite a very extensive and a very vicious type of cancer.

A young woman under thirty years of age was taken into one of our hospitals in an almost moribund state from a massive intraperitoneal hemorrhage, incident to a large perforation of the fundus of the uterus from a decidnoma malignum. The surgeon was compelled because of the critical state of the patient to perform a rapid supra-vaginal hysterectomy. Her convalescence was slow; she left the hospital in a very precarious condition and was readmitted six weeks later almost ensanguinated from a massive vaginal hemorrhage. On examination, a large fixed mass was found in the left side of the pelvis, and a deep irregular crater occupied the site of the cervix. A hasty cauterization was done to save her life. Notwithstanding the hopeless outlook, two applications of 100 milligrams of radium were made at a six weeks' interval. After the first radiation the bleeding ceased and her recovery was nothing less than astounding. This patient's five-year period has been reached, and she is now well and actively engaged in her household duties and has adopted a child. Were we to let this case occupy the center of the limelight and ignore the cases within the shadow a very brilliant argument could be constructed in favor of radium; but surgery has just as remarkable instances of unexpected cures, and we must, therefore, turn to a summary of all cases in order to find a judicial equilibrium. In these startling cases, however, we feel that there may be further guides towards still better results. Possibly through the use of radium or its emanations carried into the depth of a growth a further advance may be made. At least these remarkable cases furnish a further sustaining argument in favor of the cure of cancer so long as the process is still localized and without metastasis when it is attacked either by surgical means or radium.

Other cases in our series are equally noteworthy. It is not our purpose, however, to lay great stress upon these highly gratifying isolated instances, but to base our discussion upon the influence of radium in those patients who are not healed. Time will soon establish the question of final cures. In the meantime we feel that a very important advance has been made in the palliative treatment of even the hopeless cases. Thus, in our cases hemorrhage has almost invariably been stopped for a considerable period, in some never returning, in others recurring at variable periods before the death of the patient. In still others it has been notably lessened, and but seldom has it not been influenced. No argument is required to confirm this beneficent palliation in the case of fear-stricken women, for to those who witness it the results are self-evident. The malodorous discharges are likewise eliminated in a considerable proportion of cases. As to its alleviatory influence on pain we cannot claim so much, and yet it frequently acts most happily in this direction. In radium cases, as in surgery, however, we must meet lay criticism as well as professional pessimism where pain is not relieved after radiation, or comes on later in the course of the inoperable case. Frequently this acute terminal agony is charged up to the account of radiation by relatives or friends of the patient, and occasionally the objection to the use of this novel remedy is sustained by the family physician. Every surgeon knows that surgery is likewise condemned under the same conditions. In all propaganda work, therefore, among laymen as well as within our professional circle, the fact should be emphasized that while cancer in its earlier stages is always painless, in its terminal stages it is nearly always agonizing. In this way only may false assumptions concerning any remedy which fails be overcome. In the occasional case in our series in which the pain has been especially severe, we have felt

that possibly there might be a shadow of suspicion in support of this hypothesis; and yet within a few days another case may be seen with identical symptoms in which no treatment whatever has been applied. Even admitting such possibility in the occasional case, the many others which have found relief from pain easily overbalance these objections.

Finally, are there any untoward sequellae chargeable to the radium account? Two are possible. First, does radiation produce pain shortly after the first or second sitting? Occasionally it does. In anticipation of this possibility, we warn the patient not to be alarmed should it occur, for in a small percentage of cases, notwithstanding every care exercised in the protection of the rectum, a very acute proctitis may follow. In such cases, a decided stranguary may be noted at variable intervals, from a few days to three or more weeks, after radiation. Mucous and even blood may be discharged and the pain may be so severe as even to require hypnotics. In some cases opium suppositories may be necessary to quiet the patient. In others, a mucilagenous suspension of bismuth subnitrate by rectal injection may be quite sufficient to soothe the pain. In general, however, this symptom is the exception rather than the rule and will be noted less and less frequently as precaution is observed in the protection of the rectum and bladder. Still less frequently is vesical tenesmus noted, and as a rule it is of a more evanescent type.

As to fistula, we have noted seventeen, nine recto-vaginal and eight vesical. By no means should all of these fistulae be charged to radium, for in over 200 cases of inoperable cancer which are not treated, this terminal event will certainly occur in a larger number of patients. We are convinced, therefore, that such distressing phases of cancer of the cervix are actually prevented, for in the large number of cases of deep ulcerating cervical craters, which were locally healed, there has been no further trouble in this locality, the patient ultimately dying of metastasis or deep pelvic extension.

Briefly stated, therefore, we see in the use of radium in inoperable cases of cancer a greater tendency to relieve pain than to produce it, and also a smaller percentage of fistulae after its use than in the patients going to their death untreated, or after various palliative operations have been performed or the actual cautery has been applied. Through the results achieved by radiation in this group of inoperable cases the question is forced into the foreground: Shall we abandon the radical operation in all cases in favor of radiation? As yet, we cannot wisely answer it. Certainly the questionable operative case must be transferred to radium therapy. In the definitely operable case with a well-circumscribed area and no broad ligament extension, we still advise hysterectomy and follow this procedure in about fourteen days later with a 100 milligram application of radium for twelve hours. We base this adherence upon the certainty of a definite percentage of cures obtained through surgical intervention. On the other hand, the transfer of the questionable case to the less drastic procedure is based upon the certainty of a large surgical mortality, the frequency of disabling sequellae and the distressingly high percentage of recurrence after even the most radical operation.

Thus far we know that radium effectively supplements surgery, and within the next five years it may possibly supplant the radical operation in even the early case.

Finally, as to the question of operation after radium has reduced the inoperable to apparently an operable stage: Upon this issue we find no reason to change our position as formerly expressed, for there is no convincing argument in favor of this plan. We feel convinced that surgery can accomplish nothing further: on the contrary, we believe that surgical intervention is most hazardous. The connective tissue contractures in the vaginal vault and parametrium incident to radiation must render the dangers of injury to the bladder, ureters, and rectum greater, and the disruption of connective tissue which may actually have

encapsulated the carcinoma may lead to a reimplantation of malignant cells, which may have been held in leash or have actually been rendered inocuous. On the other hand, in the positively operable cases we commend the plan advocated by Howard Taylor. He radiates all operable cases a few days before hysterectomy is performed. This appears most logical, for he intervenes before the actual destructive changes have taken place and in his experience finds no increase in the difficulty of a panhysterectomy. This, however, is a very different proposition from that offered after a deep crater has been apparently healed and upon its site dense hyalinized tissue has formed which drags the base of the bladder, ureters and rectum into close juxtaposition.

TECHNIQUE

As to technique, we have not varied from that described in preceding articles. One hundred milligrams are applied at one sitting and repeated at a second interval six or eight weeks later. If no improvement is noted after the second sitting, we make no further application, as we have seen no benefit accrue from a third treatment when the two preceding have failed.

Our technique is a simple one. The silver or platinum radium containers, as they come from the radium laboratories, are encased in black rubber drainage tubing, carefully tied at both ends. The site of the cancer must be exposed with one or two Syms' specula, as necessity demands. Usually a gauze tampon which forms a buffer between the rectum and the cancerous area is carefully applied and upon this the radium tubes rest transversely to the axis of the vagina. Above, the radium gauze is further packed to protect the bladder, followed by a liberal but not uncomfortable gauze tampon within the vagina. Frequently the vaginal vault may be much more expeditiously exposed by placing the patient in the Syms' or knee-breast posture. Indeed, in some instances, the latter posture greatly facilitates the more accurate placing of the radium tubes. The patient usually remains in the hospital one or two days.

In only one case has anything untoward occurred immediately after the application. This patient was greatly depleted by hemorrhage, and a deep crater under the bladder was present. Soon after radiation she developed all of the active symptoms of uremia and died in coma within a few days. This is the only instance in all of our series of any atypical phenomenon, and in view of the fact that many of these advanced cases die within a month or so after radiation from the ultimate results of the disease, we see nothing noteworthy in this one event.

The second application is made in the same way. Subsequently we try to see these cases or secure a report from the family physician or the patient every three months.

From our summary of 209 cases, we find no cause for discouragement, for we have seen splendid palliative results from radiation, and we hope that with a further development of technique, cancer of the cervix may be removed from the surgical domain. In this possible transfer we are sure we shall find few dissenters among surgeons, for certainly we have no grounds for optimism from a radical operation in the pathetically small percentage of operable cases. For every case which may with reason be submitted to operation at least ten will fall by the wayside because they apply for help too late. To these wretched sufferers radium offers a palliative boon and even a possibility of cure. In cancer of the fundus the results in favor of hysterectomy are too satisfactory to be jeopardized by the use of radium, although in at least four cases we have witnessed a very favorable outcome in patients in whom there were grave contra-indications to surgical measures. In two instances a cure appears to have been effected. For patients, therefore, suffering with complications prohibiting an operation radiation offers a decided hope, for in no anatomic situation may we so certainly secure the full force of the radium without ill results. The emanations are confined to the fundal cavity and the muscular uterine walls

shield other organs from injury. Thus far, there has apparently been no attempt to find a uniform plan of application, each reporter has apparently been no attempt to find a uniform plan of procedure, each reporter of his experience having followed a method differing from his colleagues. It seems to us that this Society should take cognizance of this matter and appoint a committee to bring forward standardized suggestions.

Results of Radio-Therapy in 209 Cases of Cancer of the Female Genito-Urinary Organs

1914

Living	
4 years 4 months	1
Dead	
2 Months.	1
5 months	1
6 months	1
12 months	1
21 months	1
2 years	2
3 years	1
	8

1915

Living	
3 years 3 months	1
3 years 10 months	1
3 years 6 months (urethra)	1
4 years (chorio epithelioma)	1
	4
No report	1
Dead	
3 months	2
5 months	1
6 months	1
4 months	1
12 months	3
10 months	2
13 months	1
20 months	1
4 years	1
4 years 2 months (Died from T. B.)	1
2 months (Labia)	1
19 months (Vagina)	1
19 months (Urethra)	1
2 years 4 months (Vulva—Died from endithelioma of lung—no local recurrence)	1
Carcinoma of fundus—died from heart failure few months after application	1
	19

1916

Living	
2 years 5 months	2
2 years 9 months	2
2 years 10 months	1
3 years	1
3 years 1 month	2
3 years 3 months	2
3 years 6 months	1
	11
Well for 22 months and then not traced	1
Well for 5 months and then not traced	1
Well for 2 yrs. and 4 mos. and then not traced	1
Well for 1 yr. and 2 mos. and then not traced	1
Well for 2 years and then not traced	1
Well for 2½ yrs. and then not traced	1
Well for 2 yrs. and 5 mos. and then not traced	1
Well for 3 years and then not traced	1
	19
Dead	
1 month	1
3 months	4
4 months	2
5 months	3
6 months	4
7 months	1
8 months	3
9 months	1
10 months	1
12 months	5
13 months	3
14 months	4
18 months	2
20 months	1
21 months	2
19 months	2
2 years	2
2 years 2 months	1
2 years 3 months	2
1 year 8 months (fundus—death from cerebral embolus)	1
6 months (vulva)	1
	46

1917

Living	
3 months	1
4 months	1
5 months	1
6 months	1
11 months	1
12 months	2
14 months	1
15 months	1
17 months	2
21 months	1
2 years	1
2 years, 4 months	1
9 months (fundus)	1
16 months "	1
17 months "	1
18 months "	1
11 months (vagina)	1
16 months "	1
21 months "	1
Not stated	2
	23
Dead	
4 months	5
5 months	3
6 months	2
7 months	2
8 months	1
9 months	3
10 months	1
11 months	1
12 months	2
13 months	4
14 months	1

17 months	1
26 months	1
5 months (vagina)	1
11 months (fundus)	1
12 months (fundus)	1
11 months (urethra)	1
14 months (vagina)	1
Not stated	1
	33

1918

Living

1 month	1
2 months	6
3 months	1
4 months	2
5 months	2
7 months	2
8 months	5
9 months	1
10 months	1
11 months	1
12 months	2
14 months	2
3 months (fundus)	2
11 months "	1
12 months "	1
4 months (vagina—following hysterectomy)	1
12 months " " "	1
14 months " " "	1
12 months (choro epithelioma)	1
	34
No report	13

Dead

2 months	1
5 months	1
9 months	1
10 months	1
11 months (fundus)	1
	5

Hemorrhage

Stopped	132
Lessened	26
Uninfluenced	13
Not stated	38
	209

Malodorous Discharge

Stopped	85
Lessened	26
Uninfluenced	28
Increased	14
Not stated	56
	209

Pain

Relief	49
Unrelieved	34
Lessened	8
Not stated	118
	209

Fistulae

Vesico-Vaginal	8
Recto-vaginal	9
	17

THREE YEARS' EXPERIENCE WITH RADIUM IN CANCER OF THE UTERUS*

BY ERNEST CHARLES SAMUEL, M.D.

Radium Institute of New Orleans

NEW ORLEANS, LA.

THE Radium Institute of New Orleans was founded for the purpose of using radium for the cure and relief of patients when, in the judgment of the members of the institute, radium was indicated. We have at our disposal at Touro Infirmary a special section of the hospital where three patients are taken during the day and three at night, so our supply of radium is always at work.

In the last two years, I have limited my exposures for malignancy of the uterus to twelve hours, not using over 50 milligrams of the element, the dosage being 600 mg. hours for each treatment. My first year was very disastrous—I think I was over-enthusiastic, using 150 mg. of the element for 12 hours and in a few cases for a longer time. Seeing the marked benefit from the smaller dosage, I thought larger doses and heavier screening would accomplish better results. It took me about one year to get my bearings. After seeing quite a number of fatalities which I knew were due to overdosage, I wish to make the plea before this meeting for *smaller* doses and at least a ten-day interval between .exposures, filtering more at each exposure and stopping for four weeks at the end of the third exposure. I have been able to accomplish just as good results with this method as I did with the larger dosage, and with more comfort to the patient. The patients are not toxic after the smaller dosage; the bladder symptoms, I was having, are eliminated; no proctitis is seen—all of which we know make the patient more miserable than does the growth. I generally give three cycles of three treatments each with, as stated before, four weeks' rest after each cycle. At the end of three months the treatments are resumed. A piece of tissue is always removed or a diagnostic curettage is done before the treatments are begun; no cases are received unless they will submit to the procedure. At the end of three months, a piece of tissue is again removed, if possible, and studied by the pathologist. While I realize this does not mean much in the prognosis, because in the large majority of cases that we see, the parametrium is undoubtedly involved, it acts as a control to further treatments.

There is no doubt that the wide publicity that has been given the subject has done some good in leading patients to consult the doctor earlier; but I am sorry to say the profession is largely to blame for the hopeless, inoperable cases that we see daily. Of the patients who apply to us for treatment, at least 80 per cent are already in the inoperable stage; quite a few will give a history of having consulted their family physician and having been given a douche; in other cases ergot was prescribed and they were told it was the "change of life," and not even a vaginal examination was made. When the doctor finally discovers the true condition and the patient is rushed to the surgeon or the radiotherapeutist, and when surgery or radium fails, both are condemned.

The entire problem that must be considered in successful treatment of carcinoma of the cervix must be based upon the invasion of the new growth. The radical operation has proved that the hopeless cases are those of the metastatic type, and everything must be directed toward the local vaginal and cervical disease; if the growth has invaded the parametrium and around the uterus also—if the iliac glands are involved—the case must be considered hopeless and radium gives the greatest percentage of re-

*Read at the Third Annual Meeting of the American Radium Society, Atlantic City, N. J., June 5, 1919.

lief to the patient, controlling the local disease, stopping the discharge, pain and hemorrhage.

The operable cases are operated on without delay, and though radiation is given just as soon after as possible, with radium and deep roentgen therapy, we do not give a preliminary treatment before operation, as the operators have found considerable difficulty with the tissues that have been radiumized. It is very difficult to control hemorrhage, as the parts are very friable; even the cases that are inoperable when first seen and by treatment are apparently rendered operable, are let alone. Recently Kohlmann, in the Gynecological Service at Touro Infirmary, has been making an abdominal section and tying the iliacs, and, as soon as the patient is over the surgical shock, radium has been introduced into the vagina and been placed against the growth in the usual way; the cases seem to do better by this plan. He is working along the old theory of cutting down the blood supply to the parts and assisting radium in that way.

Radium, in our hands, has offered the most helpful outlook for the palliation and, occasionally, for the cure of cancer of the uterus; but I think the majority of the profession expect too much in the form of absolute cures. Such has not been our experience; in fact our results are disappointing, as only a small number of our cases have remained well for over two years. All the patients apparently do very well for the first eight to twelve months, and during this time it is very hard to find any evidence of the growth by inspection—vaginal or abdominal palpation. They will start to complain of vague abdominal pain; upon examination we find marked evidence of a recurrence, and in our experience it is useless to resume the use of radium, as in the majority of cases it is like adding coal to the fire. Why the carcinoma cells act in this way I have not been able to explain; deep roentgen therapy seems to offer more in a palliative way at this stage than does radium.

I regret to have to report the results of our observation in this particular field as I must admit I expected more. Reports from other clinics are more encouraging, I think, than ours—why, I do not know!

There is a wide divergence of opinion among our workers in regard to the proper dosage, and I hope this Society will take steps toward a standardization of some method that we can adopt, especially in regard to the amount to use and the length of exposure. Screening has become fairly standard, brass being the one of choice.

The youngest patient treated for malignancy of the uterus was twenty-four years old. We were able to control the growth for a while but, as I said before, I was too enthusiastic and gave her 3,200 mg. hours in three treatments; she developed a septic diarrhea and died in ten days. No postmortem was allowed. Our oldest patient was seventy-nine years old; I gave her only one treatment of 425 mg. hours and she improved wonderfully and is alive to-day—that was one year ago. The next oldest was seventy-eight years old with a growth in the cervix; I gave her 2450 mg. hours in four treatments and she is well to-day. The patients beyond 60 years old seem to do better. Our average age has been between 45 and 55, and the average duration of life, after radium treatment was begun, has been 18 months to two years. The cases treated with the Percy cautery do not do well with radium treatment, as they are already toxic and any addition causes trouble. The average number of treatments given was six in two cycles of three each, using 50 mg. for twelve hours, which gives 3600 mg. hours.

No.	*Age*	*Symptoms*	*Previous Treatments*	*Mill. Hours*	*No. of Treat.*	*Results*
71648	48	Hemorrhage after menopause	Cauterized with Percey cautery; vesico-vaginal fistula as a result, recurrence in vagina	1500	3	Improved; no late reports

No.	Age	Symptoms	Previous Treatments	Mill. Hours	No. of Treat.	Results
58758	59	Has a bloody discharge, noticed for three mos. Operated, March, 1917, Panhysterectomy	Operated March 1917 for carcinoma. Panhysterectomy	1500	3	No recurrence to Dec. 1918; no later report
57311	49	May 1916 noticed a vaginal discharge which became bloody and foul	Panhysterectomy Aug. 1916, recurrence in vaginal wall and bladder	3025	3	Improved. Growth did not disappear. Patient died 8 mos. later
73446	39	Watery vaginal discharge for one year. Very foul odor; large fungating mass.	Local application	1400	3	Discharge stopped, feels better, has gained weight. Coming for further treatment
73560	62	Hemorrhage, vaginal discharge, broken down cervix	Iliacs tied	500	1	To return for further treatment
68791	48	Hemorrhage one year ago	Cauterized	1000	2	No improvement; died one month later
58199	70	Nov. 1, 1916, had hemorrhage	Curetted—large fungating mass in vagina	2500	4	Very much improved at last examination. No late reports
53448	58	Loss of blood first noted June, 1915, continued up to operation on Jan. 28, 1916. Hysterostomy	Hysterotomy	2575	6	Well for 8 mos., return of symptoms, death at end of 12 mos.
72851	51	Loss of weight, bloody discharge treated for two years, local application		500	1	Died at end of two weeks
60168	47	Dec. 1916, had a pinkish watery discharge, latter very profuse and foul. Then a flooding spell	Cervix cauterized 20 yrs. ago for ulceration	2200	4	Symptoms controlled for 1 yr. return of growth in vagina, no response to inquiry
56461	61	Aug. 1916 vaginal discharge, dark like coffee stains which continued. Admitted for radium Nov. 3, 1916.		10575	14	No discharge, unable to find trace of growth. Last treated Nov. 4, '17.
65968	49	First noticed hemorrhage Often having a foul vaginal discharge for six months		5300	10	Symptoms controlled for 8 mos. Local recurrence in vagina. Still alive
72014	45	Hemorrhage Nov. 20, 1918		1500	3	No return of hemorrhage, no evidence of growth, unable to get reports
71759	51	Bloody vaginal discharge, very foul, for three months		1000	2	Improved at last report
68161	39	Hemorrhage	Local treatment	1000	2	No report
53757	69	Vaginal discharge, slight odor, had hemorrhage following douche	Curetted and cauterized	9275	10	Patient first treated in June 1916. At last examination Dec. 1918, no evidence of growth
64878	67	First noticed bleeding when at stool, gradually increased until large clots were passed	Panhysterectomy	4000	5	Patient was well for 1 yr. returned with growth in ligaments. Going down rapidly

No.	Age	Symptoms	Previous Treatments	Mill. Hours	No. of Treat.	Results
60236	33	Vaginal discharge followed by hemorrhage	Panhysterotomy	1100	1	No report
69390	43	Yellowish discharge, no odor, followed by hemorrhage	Abdominal operation, does not know what was done	4500	9	Very well for 18 months. No report since
73157	59	Noticed a bloody discharge, very offensive, inoperable	Local treatment	700	2	No report
64330	49	Watery discharge. Streaked with blood	Operated upon; does not know what was done	1100	2	Temporary improvement; no report after 2 mos.
60060	27	Pain in back, white discharge, became bloody	Panhysterectomy	825	1	No report
63843	49	Bloody discharge	Hysterotomy	550	1	No report
66740	57	Bloody discharge, followed by hemorrhage	Hysterotomy	1600	3	At last examination slight infiltration in vaginal scar, no symptoms
70026	44	Frequency of urination Vaginal discharge	Amputation of ulcerated cervix	2000	4	No return of symptoms
57259	43	Hemorrhage, large growth of cervix	Curetted	4000	6	No evidence of growth at last examination
63372	70	Vaginal discharge 30 yrs. after menopause, followed by hemorrhage, large mass	Local treatments	1500	2	No report
66900	67	Hemorrhage, stopped for a while from use of douches prescribed by doctor, large mass	Local treatments	1500	3	Very much improved. No late reports
71501	39	For past 18 mos. has had a yellowish discharge, then followed by hemorrhage	Operated on out of city. Does not know what was done	10000	10	Temporary improvement, involvement of rectum later. Death at end of 10 mos.
71839	68	Bad vaginal discharge, very foul odor, followed by hemorrhage	None	2000	3	Very marked improvement in symptoms; last examination no evidence of growth
73491	55	Developed bad vaginal discharge with hemorrhage; not examined until admitted to hospital—large fungating mass	None	25000	6	Temporary improvement lasting 6 mos. Vague pain in abdomen, abdominal metastis
59585	69	Bearing down pains in lower abdomen; frequent urination followed by bloody discharge	Hysterotomy	2500	4	Improved for 8 mos. Return of growth in vaginal scar. Died
68299	37	Watery discharge on examination, large ulcer of cervix, diagnosis from scraping malignant	Local treatments	1500	2	Ulcer healed. No report from patient
58251	47	Foul vaginal discharge with hemorrhage	Local treatments	5500	4	Marked improvement. No evidence of recurrence for 3 mos. Patient died from uremia

No.	*Age*	*Symptoms*	*Previous Treatments*	*Mill. Hours*	*No. of Treat.*	*Results*
61285	48	Eight months before noticed a white discharge, vile odor, became large	Percey cautery	3000	6	No result as patient had a vesico-vaginal fistula from cautery. Died in three mos.
68358	26	Vaginal discharge. Streaked with blood. Large mass in cervix	Operated on; thinks growth was removed from cervix	1700	3	No report; did not return
73359	37	Constant watery discharge streaked with blood	Cervical operation one year ago, no result, internal iliacs tied	2200	3	Doing very well. Has not reported in last 4 weeks
71192	57	Pain in lower abdomen and burning in vagina; large ulcerated cervix	Local treatment	1500	3	No evidence of growth on cervix; patient later reported considerable trouble with bladder. No evidence growth
63919	52	Bladder irritation, vaginal discharge, large mass in vagina	Local treatment	1100	3	No report
55505	64	Vaginal discharge for three years, became bloody	Local treatment	2800	3	No reports
64796	50	Watery vaginal discharge, very foul. Become bloody followed by hemorrhage	Local treatment	1100	2	No report
73095	68	Vaginal discharge, which became bloody, large mass in vagina from cervix	Local treatment	2300	3	Condition very much better. Last examination still shows evidence of growth
56377	48	Greenish yellow vaginal discharge followed by bloody discharge; large foul mass in vagina	Vaginal operation; does not know what was done	4075	4	Patient remained well for 2 yrs. Returned recently with large mass in abdomen — going down rapidly.
59439	54	Pinkish discharge followed by bleeding	Hysterectomy	4000	7	At last examination patient very much better. No late reports
64230	50	Vaginal discharge followed by hemorrhage	Panhysterectomy	3500	6	At last examination found patient very much better. No symptoms at last report
68236	62	Bloody discharge	Local treatment	1600	3	Patient's condition at last report satisfactory
62950	39	Bladder irritation; vaginal discharge	Panhysterectomy	1100	2	Vesico-vaginal fistula; evidence of carcinoma. No effect of radium
57993	47	Vaginal discharge, became bloody.	Panhysterectomy	1100	2	No report
55921	53	Vaginal discharge followed by hemorrhage, large mass in abdomen	Local operation on cervix	1200	1	No result, death in 2 mos.
59980	52	Offensive watery discharge, became yellowish, noticed some blood	Percey cautery	5000	6	Patient was full of symptoms for 6 mos., growth returned in vagina. Death at end of 12 mos.

No.	Age	Symptoms	Previous Treatments	Mill. Hours	No. of Treat.	Results
56465	43	Bearing down pain in abdomen, large hemorrhage with clots	Panhysterectomy	20000	4	No result from treatment. Very toxic after large doses. Infiltration of rectum. Death in 6 mos.
63724	55	Discharge, followed by hemorrhage	Panhysterectomy	15600	14	Temporary improvement, Infiltration of rectum and bladder. Patient at last report doing very badly
64861	45	Frequency of urination, long periods ulceration of cervix, specimen showed malignancy	Local treatment	3000	5	Marked improvement for 6 months. Return of growth in broad big amount, patient going rapidly down
73329	51	Discharge followed by hemorrhage	Panhysterectomy	1000	2	Unable to get reports
60953	55	Bladder symptoms followed by hemorrhage	Panhysterectomy	3000	4	Patient has remained well for 18 mos. Last report no symptoms
69840	38	For two years had yellowish discharge, was given douche, not examined, followed by hemorrhage from fungating mass	Vagina cleaned out	1000	2	No result patient died in 3 months
55783	39	Vaginal discharge for 3 months becoming increasingly blood-tinged. No pain	None	1912	3	Marked improvement generally and locally
67253	60	Bloody vaginal discharge beginning three months ago. Several profuse hemorrhages. No pain	None	1400	3	Bloody discharge decreased
58769	42	Ten months ago began with vaginal discharge bloody in character becoming constant. Pain in lower abdomen	During course of treatment panhysterectomy, ligation of iliacs	3520	5	General condition improved. Bleeding stopped
69062	59	Bloody vaginal discharge during past six months	None	1500	3	Discharge decreased
63298	49	Three weeks ago began to have bloody discharge	Panhysterectomy	2640	4	Bleeding lessened
62686	39	Continuous vaginal discharge during past year bloody and foul. Profuse hemorrhages at intervals	None	1350	2	Bleeding checked
60081	56	Bloody vaginal discharge charge beginning six months ago. Offensive odor. No pain	None	4995	10	Discharge distinctly improved, also general condition
57794	60	Pain in lower abdomen, bloody discharge, later becoming watery, bleeding recurred after operation	Nature of previous operation unknown	2040	3	General condition and discharge improved

No.	*Age*	*Symptoms*	*Previous Treatments*	*Mill. Hours*	*No. of Treat.*	*Results*
72858	48	Continuous uterine bleeding with yellow discharge, frequently passes large clots of blood	None	1500	3	Improved
71681	38	Slight bloody discharge following operation 4 months ago. Pain in lower abdomen and back	Curettage	2950	4	Improved
58292	42	Metorrhagia and menorrhagia beginning two years previous. Pains lower abdomen, loss of weight	None	1075	2	Unchanged
56357	45	Pain in abdomen and back. Bloody discharge during past year becoming more and more profuse	Cautery treatment	2610	2	Unchanged
57019	33	Continuous bloody discharge	Amputation of cervix	2140	2	Died
68035	54	Pain in abdomen and back, ulcerated cervix	Ligation of int. iliacs	523	1	Unchanged
69492	43	Small vaginal tumor. Slight bleeding	None	3200	5	Bleeding decreased. Tumor decreased in size
62312	64	Bloody vaginal discharge beginning 18 months ago. Abdominal pain marked	None	3205	5	Amount of discharge lessened. Pain controlled
59211	32	Intermittent bloody vaginal discharge during past 7 yrs. becoming more profuse and more foul. Abdominal pain	None	4750	8	Discharge markedly improved. General condition improved
65652	61	Intermittent bleeding past 15 yrs. Recently has had several hemorrhages. Pain in right side	None	1840	4	Bleeding decreased in amount and frequency. Pain controlled
68385	51	Vaginal discharge past 7 yrs. Becoming blood-tinged during past year. Profuse and foul at present	None	2300	4	Bleeding is lessened
60522	35	Vaginal discharge began 2 mos. after operation, becoming blood-tinged. Marked lower abdominal pain	Panhysterectomy	1700	3	Local and general condition improved
61716	54	Hemorrhage 7 mos. ago. Intermittent bleeding since. Some odor to discharge	None	4335	7	General and local condition decidedly improved
59931	70	Two months ago had a severe hemorrhage and there has been continuous bleeding since	None	5350	7	Temporary improvement in discharge

No.	*Age*	*Symptoms*	*Previous Treatments*	*Mill. Hours*	*No. of Treat.*	*Results*
61111	45	Intermittent bleeding—marked odor	Curettage	2030	4	Discharge controlled
68879	53	Continuous bloody discharge, no pain	None	2900	4	Bleeding markedly checked
65348	33	Profuse vaginal discharge, slight odor, very little blood	None	4075	8	Very marked local and general improvement
59872	59	Offensive vaginal discharge becoming bloody during past year. Path-adeno-carcinoma	None	6080	10	Great general improvement, also locally
60184	65	Severe hemorrhage 3 weeks ago which has continued since though less in amount	None	3975	3	General condition improved
71748	35	More or less continuous bleeding—Path. carcinoma simples	None	2100	4	General and local improvement.
61784		Slight vaginal discharge	None	1200	2	Improved, unable to hear from
57944	40	Almost continuous bleeding, checked temporarily by operation but reappearing. Pain	Operation not known	750	1	Improved
57551	64	Yellowish vaginal discharge beginning 5 mos. ago, becoming bloody. Bloody with foul odor now, moderate pain	None	2125	3	Improved
62001	54	Profuse discharge began 2 mos. ago, foul odor. No pain	None	2050	3	Improved
67054	50	Profuse bloody vaginal discharge—large fungating mass	None	2700	3	Died
66336	79	Vaginal discharge during past year, foul, bloody; no pain	None	425	1	Improved
56753	46	Profuse bleeding 2 mos. large ulcerated cervix —bleeding not constant —no odor	Exploratory showing extensive infiltration	9485	8	Improved
67040	44	Since operation one year ago has had vaginal discharge. Later has become odorous and bloody	Panhysterectomy one year ago	2975	5	Discharge temporarily decreased.
63138	47	Irregular bleeding past 10 months, pain in left abdomen. Uterus large and hard. Carcinoma of cervix by P.D.	None	1025	2	Discharge is lessened
62491	71	Five months ago slight bloody discharge. Began becoming worse. Clinically cervical carcinoma	None	2575	4	Discharge lessened; local condition improved

No.	*Age*	*Symptoms*	*Previous Treatments*	*Mill. Hours*	*No. of Treat.*	*Results*
62685	41	Almost continuous bleeding during past five months. Foul odor to discharge. Pain in lower abdomen	None	1625	3	Discharge markedly decreased
64764	66	Path. diag. carcinoma of cervix. Vaginal discharge beginning three months ago	None	1900	3	Discharge ceased. Local condition improved
64903	78	Bloody discharge during past 2 months. Considerable lower abdominal pain	None	2450	4	General condition improved
67523	51	Bloody vaginal discharge began 7 months ago. This has become more marked	Cauterization	550	1	Discharge decidedly decreased
64500	42	Painful urination. Constant moderate bleedings. Slight vaginal pain	Operation, nature unknown	3275	5	Bleeding decreased
61359	51	Loss of weight during past 8 months. Bloody vaginal discharge	None	1950	4	Decrease in vaginal discharge
55321	47	Pain in rectum beginning two years ago. One month ago bloody vaginal discharge began	None	8400		Condition temporarily improved permitting hysterectomy. Eventual death
57648	42	During past three months bloody vaginal discharge has increased. Abdominal pain	None	2637	4	Decided improvement in vaginal discharge
62287	40	Intermittent bleeding, cervical tissue shows adeno-carcinoma	Hysterectomy during course of treatment	3625	6	Bleeding checked
71161	43	Yellowish vaginal discharge; no odor	Panhysterectomy three months ago	1000	2	Discharge lessened
64887	58	Slight vaginal discharge beginning 5 months previous	Removal of fibroid 5 years ago. Cauterization	1100	2	Discharge lessened
58086	45	Continuous bleeding of small intensity during 4 months. Pain in lower abdomen and vagina. No urinary disturbances.	None	1312	2	Improved
67385	61	Occasional bleeding. Slight vaginal discharge. Slight abdominal pain	X-ray	500	1	Improved
59131	43	10 months began to have slight bloody discharge. During past 2 months flow has been constant. Abdominal pain.	Iliacs and ovarian tied	5125	8	Flow reduced in amount
66058	54	Yellowish vaginal discharge began one year ago, becoming offensive in odor and more constant. Occasional pain	Five years ago, panhysterectomy	1550	3	Pain relieved. Flow decreased in amount

No.	Age	Symptoms	Previous Treatments	Mill. Hours	No. of Treat.	Results
55835	43	Constant abdominal pain during past 3 months. Vaginal discharge becoming odorous, occasionally bloody	None	6440	7	Marked temporary improvement followed by death
60371	33	Abdominal pain	Panhysterectomy. Ligation of int. iliacs. Diagnosis pathologic carcinoma	2575	5	Marked improvement in local condition.
55353	34	Intermittent bleeding after exertion, abdominal pain increasing. Also constant bleeding	Operation; nature unknown	4500	6	General and local condition improved
59523	70	Abdominal pain. Bloody vaginal discharge. Irregular	None	5125	8	Improved
71649	56	Profuse vaginal discharge, bloody in character	Three previous applications	1500	3	Improved
68330	67	Profuse bleeding following cervical cauterization	Cauterization of cervix	500	1	Improved
56042	51	Profuse bloody discharge Pain in abdomen. Discharge now has odor	None	3225	1	Improved
66252	34	Slight bloody discharge at first, now yellowish in character. No pain. Cervix eroded	None	6900	8	Improved
57610	35	Profuse bleeding. Uterus enlarged, hard and tender. Pain in left side	Amputation of cervix. Another operation, character unknown	2100	3	Improved
50954		Slight bloody discharge.	None	3600	2	Improved
	36	Bloody vaginal discharge followed by hemorrhage	Panhysterectomy	8210	11	Patient was very much improved for 18 mos. Return of growth; died
67995	45	Bloody vaginal discharge.	Panhysterectomy	475	1	No report
54090	24	Vaginal discharge. Large mass in uterus and cervix	Mass cleaned out	3200	3	Patient did very well; became septic, probably too much radium; died
54776	44	Bearing down pains and vaginal discharge; followed by hemorrhage—vaginal fistula	Mass removed	1575	1	Patient became septic, probably from radium; died
71760	55	Small tumor mass in vagina, intermittent bleeding	None	2700	2	No report
57141	39	Bloody vaginal discharge past two years. Watery discharge after operation	Panhysterectomy one year ago	2650	5	Patient did well for 15 months
66872	44	Bloody vaginal discharge.	Panhysterectomy	2750	5	Did well for 10 months then had recurrence

THE BIOLOGICAL REACTION OF CARCINOMA CELLS PRODUCED BY RADIUM RAYS. THE TECHNIQUE OF RADIUM THERAPY IN GYNECOLOGY*

BY HENRY SCHMITZ, A.M., M.D., F.A.C.S.

CHICAGO, ILL.

A STUDY of the biological reaction of tissues to radiation enables us to interpret correctly their therapeutic value and assists us in the choice of the quantity and quality of rays to be employed.

Since the therapeutic action of radium is not only local but is also general or constitutional, a correct knowledge and interpretation of the local and systemic reactions are necessary and very important. Clinical observations of the latter furnish a guide to the determination of indications and contra-indications to radium therapy.

Not only that—a knowledge of the biological as well as the therapeutic, i.e., local and systemic reactions, will materially aid us in the correct development of the technique for the application of the rays and in the probable prognosis of radiation treatment.

We must always realize that success in cancer treatment can be attained only by the total eradication or degeneration of all cancer cells present in the body of a victim of the disease. This principle must be observed if we are to expect results, whether the means chosen are surgical or radiological. The danger in the treatment of cancer with surgery consists in the fact that we cannot always remove all tumor tissue. The vestiges left grow after such treatment with an increased rapidity, and by auto-transplantation cause secondary growths in different parts of the body. The danger in the treatment of cancer with radio-active substances arises from the fact that proliferation is enormously stimulated if we cannot rapidly destroy all the pathological cells. An accelerated proliferation increases the danger of the formation of metastases.

H. Dominici has made extensive and valuable researches of the biologic action of radium rays. He applied 100 mg. of pure radium sulphate in a flat applicator of 5 sq. cm. to the skin of a healthy animal. Within three weeks after the application he observed three varieties of change. The epidermis and cutis which had absorbed all of the alpha and soft beta rays showed a necrosis and destruction of these structures. The subcutaneous tissue and fasciae which were subjected to the action of the medium beta rays were undergoing an intensive proliferation and retrogression to the embryonic state. The hard beta and gamma rays had become absorbed in the aponeurosis, muscle and even osseous tissues which evidenced metabolic changes. In from five to six weeks after the application of the radium the epidermis and cutis had regenerated, while the other tissues did not return to a normal state for from six to eight months.

This observation demonstrated the variety of action of radium rays: necrosis, stimulation of cell proliferation, embryonal retrogression, and metabolic changes. It also showed the different behavior of various elementary cells toward the rays, which was termed by Dominici "receptivity" or "sensitiveness," and by Colwell and Russ "selective absorption." Based on these facts Bergonié and Tribondeau formed the law that "immature cells, and cells in an active state of division are more sensitive to rays than are cells which have already acquired their fixed adult morphological or physiological characters."

The degree of selective absorption of rays by the living cell depends upon the particular phase of its life cycle, its species, as well as the age of the host whom it inhabits. Cell elements which are embryonal or undifferentiated are destroyed by a radiation which would cause only a slight reaction in the

*Read at the Third Annual Meeting of the American Radium Society, Atlantic City, N. J., June 5, 1919.

surrounding mature or highly differentiated cells. The basal cells of the epidermis and hair follicles, lymphoid cells and sex cells (as ova and spermatozoa) are readily killed by an amount of rays which would leave intact the neighboring mature cells.

Selective absorption also depends upon the species of the cell, whether epithelial, connective tissue or endothelial; and on the different varieties within each species. Normal connective tissue cells are less receptive than normal epithelial cells. Epithelial cells of the basal layer of the skin are less sensitive than those of the papillæ of the hair follicles, although they are different kinds of the same species. Lastly, the tissues of a child are much more easily altered by radiation than corresponding tissue elements in the adult.

These observations made on normal cells apply with equal force to abnormal cells and tissues, neoplastic as well as inflammatory.

Remarkable examples of radio-sensitive tumors are ectodermal and basal-celled epitheliomata derived from the basal-celled layers of the epidermis, lymphadenomata originating from the embryonal lymph cells, sarcomata derived from embryonal connected tissue cells in which the connective tissue fibrillæ, cartilagenous and osseous tissues have undergone re-absorption, fibromata in which the fibroblasts are present in large numbers and do not develop into highly differentiated adult cells, and connective tissue fibers.

On the other hand squamous-celled epitheliomata, fibrosarcomata, chondrosarcomata, osteosarcomata, and fibromata in which atrophic fibroblasts and abundant fibrous tissue have been retained, are very refractory to radiation.

The action of radium rays on neoplastic cells is of an impeding, destructive and evolutional character. The radiation arrests the growth of the tumors before it destroys them or renders them harmless by an evolutional process or metaplasia. Arrest of growth results from a cessation of the function of mytosis or genocepter. Destruction of tumor cells is either a direct or an indirect process. In the direct form the tumor cells undergo necrobiosis. The cytoplasm and nucleus disintegrate, and the cells are absorbed by phagocytosis. In the indirect destruction a metamorphosis of the tumor cells precedes absorption. This consists in a hypertrophy of the cells, enlargement of the nucleus, nucleolus and even centrosomes, so they appear like pseudoparasites, and achromatism, vacuolation and granulation of protoplasm.

The evolutional influence of radium on tumor cells is evidenced by a retrogression, or stimulation of the embryonic tumor cells as they develop to maturity. To understand this process we must have a clear conception of the formation, growth and function of a cancer cell. Tumor formation deprives the cells of their normal functions. They become "strangers" to themselves and to the mature normal cells from which they originate.

The growth of tumor cells is not only the result of a proliferation of a single embryonal cell group, but also depends on a retrogression or metamorphosis of normal mature cells to an embryonal phase after they have become included in the cancer tumor. By a process of evolution the embryonic abnormal cell is stimulated to grow and develop into a mature, highly differentiated normal cell, thus becoming benign.

Let us conclude with Colwell and Russ: Very rapidly growing cells are the most affected of any by radiations. However different rays give rise to quite different effects upon one and the same variety of cell, they have a "differential" action and a careful distinction should be made between the "differential" action which different rays have upon the same variety of cell, and the "selective" action which the same kind of radiation has upon the many different varieties of cells.

Microscopic examination of tissues exposed to hard beta and gamma rays reveals the following facts: Soon after exposure, a serous infiltration, an enlargement of the cell nucleus and cell body, and a swelling of the endothelial cells lining the capillaries are seen. The lumen of the latter decreases in

size. Within seven to eight days a degeneration of the cell nucleus is evidenced by a cessation of mitosis, a pyknosis, cytolysis and achromatism, while the protoplasma evidences vacuolation and granulation. A reactive inflammatory process also appears characterized by a lymphocyte and leukocyte infiltration and the appearance of numerous young fibroblasts. It seems as if the compact tumor masses break up in small particles separated from each other by this young connective tissue. The cell debris is rapidly cleared away by phagocytosis. The fibroblasts mature into connective tissue. It would appear as if the tumor had actually vanished. However this is not the case. On more careful examination, especially in regions more distant from the radium, epithelial cells are still seen, sometimes isolated, at other times in small nests that exhibit all stages of degeneration. Whether they are dormant or absolutely harmless or dead, of course, cannot be stated. However if radiation is not continued they may again assume renewed activity leading to a recurrence.

Prime considers that these degenerative processes affect the cell nucleus in preventing mitosis. Such radiumized tissue will not grow when inoculated in mice. Radium does not kill the cell outright, but injures the nucleus in such a manner as to prevent further division, which must eventually result in the death of the cell if its energy is expended in growth and division and not in a purely mechanical function.

TECHNIQUE

In America the Wertheim operation has never been distinctly popular because of the feeling that the additional cases saved by this method do not justify the higher mortality from the operation. From the economic standpoint it must be considered that a competent Wertheim operation is beyond the reach of the great majority of the population and that all the phases of the cost of acquiring technical skill should be counted in estimating its utility. Because of these considerations a marked change has occurred during the last few years in the aspects of surgical treatment of uterine cancer, most surgeons preferring to reduce the scope of operability, and others abandoning all operations for uterine cancer in favor of radium and x-ray treatment. Earlier diagnosis has doubtless contributed to improving surgical statistics and is equally important for radium therapy. In these directions lies the hope of real advance in the therapeutics of uterine cancer.

The demonstrable reduction in size of a tumor of a kind not to be attributed to the natural processes of evolution of that tumor or its associated lesions, is the one essential feature of effective therapeutic intervention. Circulatory changes in the tumor, the relief from pain, the restoration of a secondarily impaired function and local healing, cannot be cited as indications of the specific curative action of the agent employed. The growth may continue to advance in spite of their presence. We should exclude from consideration all these secondary factors. The observation of the size of the tumor itself is the sole criterion on which we can place reliance in judging of the effect of therapeutic measures.

Accordingly we have attempted to evolve the technique of radio-therapy. The latter may be profitably divided into two parts: the dosage and the technique of application.

Dosage is a complex quantity and includes the quantity of radio-active material, the volume in which it is contained, or the area over which it is spread, the nature of the rays selected, and the time during which they are applied.

The radium tubes should contain approximately 50, 35, 25, or 15 milligrams element. The filters used for internal work can be filled with any combination of these tubes up to 100 milligrams. The 15 milligram element of radium is contained in a platinum needle with an iridium point. It may be thrust into the tumor substance, for instance, through the perineum into a lobe of the prostatic gland under guidance of a finger in the rectum, or into the substance of the tongue, the cervix, the paracervical tissues, etc.

As the therapeutic action of radium extends for a radius of about 4 cm., from 50 to 100 mg. of radium element are inserted into the uterus, if that organ is the seat of a carcinoma. Should the uterine canal measure 3 inches in length, 75 mg. are deemed sufficient; if it measure 4 inches, 100 mg., and so on. The "bomb" may carry up to 100 mg. and is placed directly against or brass capsules of a wall thickness of 0.5 mm. These capsules are inserted into a filter made of brass of a wall thickness of 0.7 mm. The filter is then surrounded by a rubber tube (fountain pen filler) of 3 mm. thickness. A thread is attached to the filter cap, which is secured with a safety-pin to an abdominal binder.

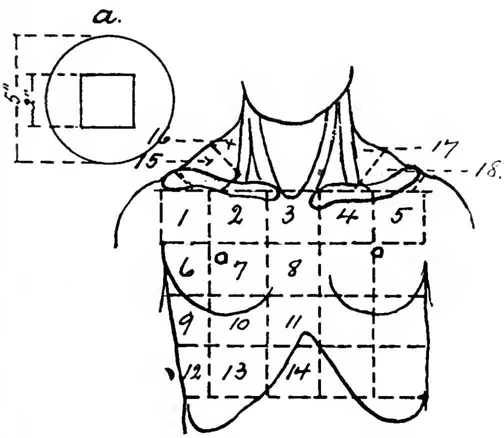


Fig. 1. Dotted lines indicate division of chest wall in roentgen treatment of carcinoma of the breast. Each field is 2 inches square. The lead disc "a" has a window of 2 inches square in center and a diameter of 5 inches, the same as the compression tube. The thickness of the plate is 5 mm. The arrangement posteriorly is the same.

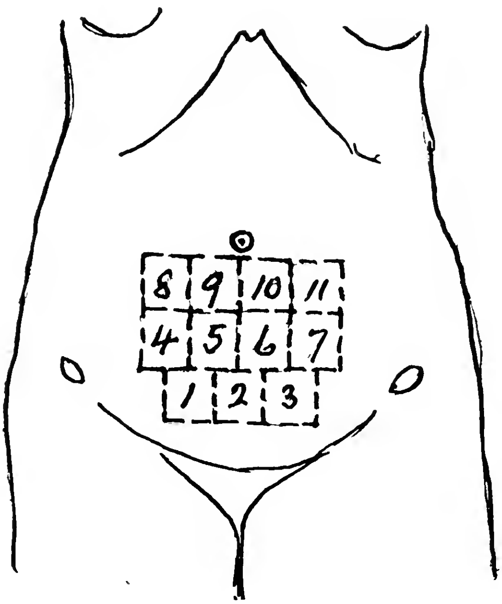


Fig. 2.

the cervix and vaginal vault if an extensive involvement of the vaginal portion of the cervix and vault are present. The rays will cause a degeneration of carcinoma tissue within a radius of 1 cm. within eight hours, within 2 cm. within thirty-two hours and within 3 cm. within seventy-two hours, and so forth. Therefore a cervical or uterine growth is exposed to the action of the rays for seventy-two hours, 3 cm. being the average extent of an area which could be effectually influenced by radium rays. Extensive infiltrations of the parametria are punctured with a special trochar which enables us to bring the element directly into these masses. The tubes are left for a variable length of time corresponding to the extent of the area.

The arrangement of the capsules is as follows: The radium is contained in silver

In noting results we observe: (1) the arrangement of the radium capsules; (2) the distance of the capsule from the tumor tissues; (3) the method of filtering; (4) the duration of each séance; (5) the interval between séances; (6) the histological structure of the tumor, if biopsy is advisable; (7) the comparison by examination of the actual size of the tumor preceding each séance of treatment; (8) the visible effects of radium on the tissues, as erythema, burns and so forth; and (9) daily examinations of the blood, including a differential white count. These are of importance to interpret correctly the latent action of radium on tissues and constitution and to determine the curative or palliative efficiency of the agent.

We observed in our earlier work that though we obtained a local regression of the

tumor evidenced by local healing, reduction in size of the growth, normal findings on palpation as to position, movability, size, form, consistency and sensitiveness of all the generative organs, the growth would continue to grow or reappear with undesirable frequency at its periphery. Evidently the rays did not destroy the distant parts of the tumor. To overcome this difficulty we resorted to a simultaneous use of the

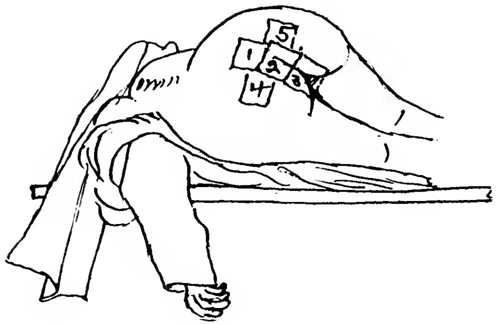


Fig. 3.

roentgen rays, and have found in them an effective means of combatting the peripheral spread of the tumor.

The technique of the roentgen rays therapy has been rendered so exact in its minutest details that carelessness or neglect are impossible. The best description is furnished by the reproductions of Figs. 16, 17 and 18. To each square 50 milliampere minutes are applied. The Coolidge tube must take a spark of nine inches, the milliamperage being 4 to 5; the rays are filtered through 0.5 mm. of zinc or 3 mm. of aluminum; the secondary rays forming in the metal filter are arrested by the distance between it and the body surface, it being placed about half way between tube and body surfaces. The distance of the anode from the body surface is 21 cm. With such an arrangement we obtain about 6 E doses, i.e., 30 X or 15 H, within 10 minutes, if the pastille is placed above the filter and 1E if it is placed on the skin surface. According to Bumm's researches, 3 to 5 E doses will destroy carcinoma tissue within one centimeter from the body surface, but it takes 7 to 10 times this amount to obtain similar results near the posterior bony pelvic wall, the seat of the glandular metastases in cancer of the pelvic organs. By using multiple portals of entrance, 7 to 12 fields suprapubically—3 to 6 over perineum and sacrum and 2 over each greater sciatic foramen—we may succeed in obtaining the same therapeutic results in the tissues adjacent to the posterior bony pelvic wall as with radium locally. We must tilt the tube so it will always be directed to the same area within the pelvis. The number of fields must be determined for each individual case, and depends on the diseased organ, the extent of the infiltration of surrounding structures, the region of the body and the location of the regional lymph nodes. An interval of three weeks is observed between each course. The latter is crowded into the smallest possible space of time, that is, the treatments are usually applied in one sitting. From three to four courses are given in each case.

In conclusion I wish to recapitulate:

1. The biological reaction of cancer cells to radiation offers the best evidence of the therapeutic efficiency and curative possibilities of the gamma rays and the hard roentgen rays.

2. The efficacy of the treatment must be based on the demonstrable reduction in the size of a tumor and not on the local changes and improvement in the subjective condition of the patient.

3. The evolution of a successful treatment must be guided by these observations, a correct dosage and a detailed and careful technique.

DISCUSSION OF PAPERS OF DRS. CLARK AND KEENE, SAMUEL, AND SCHMITZ

DR. LEDA J. STACY, Rochester, Minn.—Dr. Samuel, Dr. Clark and Dr. Schmitz have covered the ground so thoroughly that there is little to add in discussion. The point which Dr. Schmitz noted, as to the isolation of the cancer cells by connective tissue has been noted by us in the recurring nodules in the skin following amputation of the breast for carcinoma. These nodules may persist after repeated exposure to radium and upon excision may be found to contain cancer cells buried in connective tissue, without mitotic figures.

In the treatment of carcinoma of the uterus we have used radium only in the inoperable cases in which there was extension into the vaginal mucous membrane, or into the broad ligaments.

In a series of 79 cases of carcinoma of the uterus treated with radium, 54 have been traced and 25 per cent are living, the majority being alive for two years after treatment and all having lived more than one and one-fourth years.

In the recurrences the treatment has not been as successful, except in those cases in which only the vaginal mucous membrane was involved. But with extension into the broad ligaments the results have not been good. In a series of 24 cases of recurrences treated, 16 have been heard from and only 3 are living, but they have lived two and three years. One is a clinical cure and two have been operated on to repair a vesicovaginal and a rectovaginal fiistula, and no evidence of malignancy was found at the time of operation. In reviewing our statistics we are led to believe that the ideal treatment of operable carcinoma of the cervix uteri consists in a thorough cautery of the cervix, followed immediately by a total abdominal hysterectomy and this followed by a series of radium treatments into the vagina and deep *x*-ray treatment over the back and abdomen while the patient is convalescing from the hysterectomy. The series of radium treatments consists of 3 applications of 50 mg. of radium for twelve hours into the vagina, at intervals of four and five days. Deep *x*-ray treatment is given over the abdomen and back during this time. The patients are advised to return for a second treatment in three or four months. It will be a matter of time before the results of this postoperative routine can be determined.

The matter which Drs. Clark and Samuel brought up regarding the importance of the education of the laity to allow a complete physical examination in every case, and the careful watching of the patient, is most important. The report of the microscopic examination in a series of 158 cases treated was obtained in 64 per cent of the cases. In this series of 168 cases, 39 are living. As a rule, unless the growth is the proliferative type we do not remove a specimen for examination. I think Dr. Schmidt brought up the point of removing a portion for examination after radium treatment. We have discontinued this practice. In the few cases in which a specimen was removed for scientific study, the results were those he mentioned.

DR. J. M. LEE, Rochester, N. Y.—I feel that the Society is to be congratulated on having such a scientific and cultured gentleman as Dr. Schmitz to prepare a paper on this somewhat difficult subject.

Dr. Schmitz brings to us the results of his rich experience in histology, pathology and radiology, and we are ourselves to be congratulated on such a complete and clear discussion of the changes which develop in the cellular elements of neoplasms after the use of radium. There is nothing to do but to commend him for his work, which I am sure all of the members have done mentally already. Personally, I desire to thank him for his valuable paper, and in this I am sure I am seconded by the able men who make up the membership of this society.

His findings clearly show why it is that radium acts so efficiently in round cell sarcoma and other malignant growths which prior to the introduction of radium therapy, were rapidly fatal. It also gives us a clearer insight as to how it is that the agent is so successful in some portions of the body and not so much so in others; it also clears up the question as to how histology, pathology and age of the patient influence the effects of radium therapy. It is known to us all that cancer and sarcoma are more amenable to treatment in some sites than in others.

Dr. Schmitz's paper is so clear and comprehensive that we ought not to take issue with him; but since the profession is divided as to

the selective action of radium, Martin of Berlin leading the opposition, and Wickham and De Grais, particularly, favoring such theory, it seems only fair that as Dr. Schmitz has spoken of the effect radium produces on different layers of tissue in various dosage and screenage he should amplify the subject and give us the benefit of his broad experience.

Dr. Schmitz's technique, it seems to me, is above criticism, though his dosage sometimes is close to the border line of fatal toxicity. I have known 15,000 milligram hours radiation in about equal doses six weeks apart to cause death; and 35,000 milligram hours in equal monthly doses extending over a period of three months to prove fatal. Although larger dosage than Dr. Schmitz advises has been employed by a number of able surgeons, it seems to me that such large amounts are unnecessary and dangerous. I realize that many patients die from operations performed for the relief of cancer of the uterus, and we must not expect that the employment of efficient doses of radium in these deadly cases will always be entirely free from such results; nevertheless we should strive to prescribe the minimum efficient dose. The law which Dr. Schmitz follows is evidently the one advised by Wickham and DeGrais, viz.—the dosage should be increased inversely with the square of the distance.

Again, in radium therapy, as everywhere, we find that what one patient will bear with impunity will produce perceptible or even disastrous results on another. We formerly employed without hesitation to cover such a condition the word "idiosyncrasy." It is now looked upon as a sort of rubber cap to cover our ignorance, and for this reason the word is dropped. I know Dr. Schmitz has given in the first section of his paper the reasons for such susceptibility to the element when he says that malignancy in certain histologic elements are more resistant than others, and that certain pathologic growths, as the squamous-cell type, for instance are more difficult to treat successfully than others. This may be due to the fact that the diseased cells more nearly approach the normal. Again, he refers to the age of his patient and I presume large amounts of débris thrown down into the system might influence adversely the result.

He speaks of massive cancerous areas in the uterus and about the pelvis: this he may control by the use of radium loaded needles suitably screened and carried into the diseased tissues, and I believe his argument here is sound; but when he speaks of the use of the x-ray, I cannot help believing that he labors under a wrong impression. I am not in sympathy with the sentiment that seems to have grown quite prevalent all over the country, viz., that the x-ray is equally efficient with radium. I know this subject has received careful consideration before the convention to-day, but I did not hear it and I want to voice my sentiments of disapproval of the theory as advanced by able members of the profession in this particular. In Dr. Schmitz's use of screenage for the Coolidge tube, may I have the temerity to suggest that ¼ in of sole leather might be added to the aluminum screen to advantage. I am not an x-ray man and perhaps it is in bad taste for me to speak so positively on this subject; but my able assistant who handles the x-ray work at our hospital is unable to tell me why he has such unbounded faith in the machine; surely the results do not warrant it. Enthusiasm does not prove its superiority over radium.

Dr. C. H. Viol, Pittsburgh.—I would like to comment on the form of bomb which Dr. Schmitz has spoken of using to screen off the gamma rays. In talking with people I have usually expressed the opinion that it was impracticable to secure protection of normal tissues from the gamma rays by metallic screening, owing to the great penetrating power of these rays and the consequent mass of metal necessary for their absorption. But with the considerable thickness of lead which Dr. Schmitz has in his applicator the tissue lying back of it should be fairly well screened. One half-inch of lead will absorb one-half of the hardest gamma rays, and so the inch thickness of lead in his applicator, together with the gauze packing, should make it quite effective.

Dr. A. S. Fleming, Minneapolis, Minn.—We think that many of the undesired and irritating effects we have had from the application of radium, have been due to the secondary radiation from our metal applicators and screens. We now use gauze, rubber and distance, for screens. Applications to the cervix are made by wrapping the radium capsules in gauze and glove rubber; to the uterine cavity by placing the capsules in pure rubber gum

tubing and introducing them through the cervix.

Care is taken to push the bladder and rectum well out of the way by gauze packs, and proctitus and cystitis, of which we have heard so much, have not occurred.

I want to take exception to the statement made by Dr. Schmitz in reference to the action of radium. Ever since I have been studying radium, I have frequently met with the statement that insufficient dosage acts as a stimulant. So far as I have been able to observe, if it produces any effect at all, it is that of retardation or inhibition of cell activity rather than stimulation. I have not observed for instance that the periphery of a tumor was stimulated beyond the area where the inhibitive effects of radium could be demonstrated.

The statement of Dr. Samuel that the Percy cautery cases have not done well is also contrary to my experience. In cases of cervical carcinoma with extensive cauliflower growths in the vagina, we usually precede the application of radium by destroying all gross evidence of the disease with a Percy cautery. It has facilitated the effective application of radium, shortened and reduced the amount of toxaemia due to absorption from the retained products of the ulcerating and infected mass, and seems to aid in every way the patient's power of recuperation.

Dr. Albert Soiland, Los Angeles.—In the number of medical meetings that I have attended, it has never been my pleasure to listen to three highly scientific papers on one subject before. I think the Society should be congratulated. It was interesting to learn from Dr. Clark that the danger of perforation of the rectal wall from the treatment was not as great as we had been led to believe. I had always rather feared this in the cases where large doses had to be administered. It will help us in our work to know the danger is not so great as we had anticipated.

I was also glad to hear from Dr. Samuel that he uses the cross-fire method of treatment, combining radium and x-rays, and that he takes a more conservative view of the dosage, using 50 mg. as an average insertion. That is the dose which we are using in our work on the Coast.

Dr. Schmitz's talk on the histology, pathology, and therapeutics of these cases was illuminating and very instructive. I would like to ask whether in the use of his "bomb," it is difficult to keep this in place, and whether it is uncomfortable to the patient. If he will permit me to do so, I shall adopt this device in cervical cases.

Dr. H. Janeway, New York.—I wish to add my experience in the treatment of uterine cancer. My technic has been to apply three tubes in the utero-cervical angle, and in this way give three thousand mg. hours, in addition to applying a separate dose to the cervix. Formerly we used a smaller dose but now we use one of three thousand mg. hours. I have not used filtration for the vagina and have not thus far encountered any proctitis or vesical irritation. In fact, the patients have complained of very few symptoms following the treatment. I usually give only one treatment. These questions can only be settled by comparing end results, and that cannot be done right away. My oldest case goes back three and one-half years.

Dr. T. C. Kennedy, Indianapolis.—I am glad to hear some of the essayists say that they use 50 mgs. as a routine treatment in the conditions under discussion. I began the treatment of these cases with 50 mgs. but thought perhaps more could be accomplished with large doses, and tried using from 100 to 150 mgs., but am convinced that this is too much, and now as a routine practice I use 50 mgs. I am sure I get better results with the 50 mg. applicator than I did with the larger amounts.

My experience with cystitis and proctitis following the application of radium is different from what Dr. Janeway relates. Some cases have given great annoyance for several weeks. In proctitis from radium I have used injections of olive oil as recommended by Rausohoff, and have been able to relieve my patients.

The early diagnosis of cancer is very important, but frequently the patient is beyond relief before she is aware that she has the disease.

Until patients know there is something the matter with them it is very difficult to get them to go to a physician for examination.

Dr. C. E. Alliaume, Utica, N. Y.—I have used a screen similar to Dr. Schmitz's lead bomb quite extensively, but have recently discarded it because it was very uncomfortable for patients and made them dread future treatment. In vaginal treatments, I use hard rubber

plaques as screen to protect the bladder and rectum. I enclose the radium in rubber tubing which is just a little longer than the radium tube, and put it into a finger cot, the end of which is tied with a thread. A long linen thread extends from the ring in the radium screen out of the vagina, and is attached to the thigh with adhesive plaster. The radium package and protecting screens are held in place by a one-piece gauze packing. In intra-uterine radiation, I place the radium in the end of a long rubber tube of small calibre, the end of which is tied with a thread. Into this rubber tube I place a long heavy copper wire, the end being bent into a very small circle. This end is placed alongside of the radium inside of the rubber tubing and a thread is tied about the outside of the rubber tube just behind the radium, holding the wire and tubes of radium in place. This wire is of sufficient length to protrude from the vagina and to be bent up over the groin and fixed in place there with adhesive plaster. A gauze packing is introduced into the vagina about the tube as it emerges from the cervix, being packed rather firmly before the vaginal speculum is removed. A vaginal pad and "T" binder are then applied to hold it all securely in place. The only cases of proctitis which have resulted from radium treatment in my experience, have been in cases where treatments were given in or through the rectum either for rectal, vaginal or uterine lesions.

Regarding Dr. Fleming's experience with the Percy cautery, it seems incredible that many cases of uterine cancer which have developed very far could be treated without establishing the fact that in treating such cases with the Percy cautery profound sepsis is frequently produced. The Percy cautery treatment has many objectionable features, while radium has none and offers far better results than any other known treatment.

Dr. John G. Clark, Philadelphia.—As to the question of treating patients suffering with recurrence after hysterectomy I am in hearty accord with Dr. Stacey. I dread to see them come to my clinic. They resort to radium as a desperate chance, but I am sorry to say that seldom do these cases obtain even temporary relief or palliation.

With the uterus as a wedge or block between the rectum and bladder the dangers of destructive action to either of these organs is greatly lessened. When however, they lie in close contact, as they do after hysterectomy, it is more hazardous to apply radium. If the recurrence has produced a crater without an intervening barrier of vaginal tissue I now refuse to treat these cases. We can not even mitigate the symptoms and we stand big chances of producing recto- or vesico-vaginal fistulae.

As to the point in our discussion relative to the repetition of treatments, I hold that if after two applications of radium we observe no benefit the treatments should cease during this time, for in our experience it either improves the condition at once or fails. In discussing this question a few days ago before the Annual Session of the New York State Medical Society the question was asked by Dr. Cullen of Balitmore as to whether we had noted any difference in the action of radium in cases of the epithelial and adenomatous type of carcinema of the cervix. In his experience he had found that the adenomatous type was practically incurable so far as surgery is concerned. This point in the future should be kept in mind by all of us in our classification of cases. At first we curetted these cases to obtain diagnostic material; we do so no longer, for 99 per cent of the cases that apply to us for treatment are inoperable and therefore the diagnosis is self evident. Therefore, we traumatize these cases as little as possible believing that we thus serve the best therapeutic end by a "touch me not policy." Under this thought I particularly am in accord with Dr. Alliaume who deprecates the preliminary use of a curette or the Percy cautery. By all means leave the cautery out of consideration, or you will charge against the radium account fistulae caused by the cautery. So far as the dangers of a toxaemia or sepsis being caused by radiation, they are theoretical rather than real. I have seen large cauliflower masses melt down under radiation without the slightest coincident toxic symptom.

The question of technique of application should be referred to the Research Committee of this society for standardization. As soon as possible we should lay down definite rules for dosage, repetition of treatments, care of the patient, follow-up system, etc. Only by such standardization may we reach a common ground for discussion and observation. We have two schools of radium therapy, one having unlimited amounts of radium, the others in comparison having infinitesimal amounts. In considering results, therefore, they should be comparative between those who have

massive and those who have minimum amounts of radium.

As to the use of various screens used to protect the rectum and bladder in vaginal applications, I have discarded them all in favor of simple gauze packing, and it is quite as effective as lead shields, twenty dollar gold pieces, etc.

Dr. Henry Schmitz, Chicago.—I have followed the discussion with a great deal of interest and wish to thank all, especially Dr. Lee for his very fair criticism of the papers. When I mentioned the efficacy of the *x*-ray as an adjunct to radium treatment of deep seated malignancy, I spoke from actual observation; the *x*-ray will influence the growth. Creditable results can be obtained by the use of a proper technique of the roentgen therapy.

Dr. Fleming spoke about the stimulation of the cells by radium rays. There is no doubt that a certain number of cells on the periphery of the growth will undergo proliferation if the intensity of the rays is insufficient. These peripheral cells are stimulated to an increased proliferation by too small an amount of radium or too short an exposure. Experimentation proves this point. Plants may grow to a much greater size than normally by applying a small amount of radium, and vice-versa, their development may be dwarfed or crippled by an amount of radium that will injure the growing plant cells. This fact has also been biologically illustrated in animal experimentation. Therefore the same facts apply to the human body, and if we administer a dose of rays that is not sufficient to cause degeneration, we stimulate proliferation and therefore cause a rapid growth.

The reason I employ the bomb is to protect healthy tissue from the action of the rays. I have three cases under my care who have a stricture of the rectum resulting from radium treatment in the vagina. The stricture occurred at a point where there was healthy tissue. The only way I can explain this occurrence is that the recto-vaginal septum is very thin and the penetrating rays injured the healthy rectal tissue. In one instance we had to do a resection of the rectum, which relieved the patient of the severe distress. In several other cases of cervical cancers which had healed locally, we saw a stricture of the rectal wall. The patients are not incapacitated, but I have no doubt that they will be after a while on account of the progressive nature of this injury. The size and weight of the bomb has never inconvenienced the patient. The packing, which of necessity must be quite firm, gives a feeling of fullness to the patient but never a sense of weight.

In conclusion, I wish to agree with Dr. Clark, whose paper was a revelation not only to me but to all of us, that we should find some means by which this society can standardize the use of radium, that is, establish the lethal dosage, determine the best method of application, evolve practical instruments and enable us to compare the clinical findings.

THE AMERICAN JOURNAL OF ROENTGENOLOGY

Published by Paul B. Hoeber, New York City

Issued Monthly. Subscription, $6.00 per year Advertising rates submitted on application. Editorial office, 480 Park Av., New York. Office of publication, 67-69 East 59th St., New York.

Twenty-first Annual Meeting

The Twenty-first Annual Meeting of The American Roentgen Ray Society will be held at Rochester, Minn., and Minneapolis, Minn., September 15, 16, 17 and 18, 1920; at Rochester on the 15th, at Minneapolis on the 16th, 17th and 18th.

Further details and advance information concerning the meeting will appear in these columns from month to month.

The Heart Symposium

One of the more inspiring sessions of the Saratoga meeting was that devoted to the heart symposium. It was a timely invasion of a field prolific in opportunity but much neglected by the American roentgenologist. Perhaps one reason for this neglect has been the apparent self-sufficiency in cardiac diagnosis on the part of the internist. But a far more potent reason is that the roentgenologist himself has utterly failed to appreciate the wonderful fertility of this field of endeavor.

Van Zwaluwenburg has done well to emphasize the fact that roentgen-cardiac diagnosis is much more than a mathematical problem. Those eminent medical authorities who teach that a heart is abnormal when, and only when, its borders project across certain arbitrarily drawn lines, refuse to acknowledge the fact that the normal heart presents as many variations in size, both actual and relative, as does the stomach. Thus a thirteen centimeter heart might still be markedly dilated if its normal width was nine centimeters, while one fifteen or more centimeters in width might well be normal for another individual. Even less promising are the attempts to establish a standard ratio of cardiac and chest dimensions, for a broad chested individual is not infrequently endowed through heredity with a small heart, while another may receive through one parent an ample cardio-vascular system, housed within a restricted chest cavity inherited from the other parent.

There is surely much to be gained by a more careful study of muscular action as manifested by pulsation phenomena. Thus the apparent shortening and rotation of the "drop" heart in systole is quite characteristic, while in mitral insufficiency the vigorous, somewhat irritable contractions of the left ventricle, accompaniel by the distension of the auricle and pulmonary artery, are sometimes readily detected upon the fluoroscopic screen. And as the art becomes

perfected, may we not hope to see and count auricular pulsations as accurately as we now do those of the ventricle? When we are able to demonstrate two pulsations of the auricle with each ventricular beat, we shall have easy access to a diagnosis of heart block. A series of arhythmias studied by both electro-cardiograph and fluoroscope might throw new light upon them. The positive systolic pulsation of the jugular vein is a well established clinical sign of tricuspid insufficiency; but not so well-known is the positive venous pulsation within the lung hilum in mitral insufficiency. For the latter, of course, is a sign which may be observed only upon the screen.

The excellent research work of Holmes has defined certain limitations beyond which the roentgenologist cannot hope to go in the diagnosis of pericardial effusion. The physical law of relative density may not be changed to suit our purposes. And he who would see the heart shadow suspended in pericardial effusion is usually up against this immutable law. But when denied such obvious and absolute signs as this, we are compelled to fall back upon our more indirect manifestations of this process, which offer a fairly satisfactory degree of diagnostic accuracy.

It is to be hoped that more consideration will be given by roentgenologists to the study of cardiac mobility, which when abnormal, is becoming recognized as a cause of circulatory weakness.

BISSELL

BOOK REVIEWS

Los Rayos X en el Diagnostico de las Enfermedades del Estomago. By Doctors José Gonzalez Campo and José Gonzalez-Campo de Cos, Specialists in diseases of the digestive tract, Madrid, Spain. 260 pages, 17 illustrations and 28 roentgenograms. Published by Imprenta Blass y Cia., San Mateo, 1, Madrid, 1919.

This is an excellent clinical treatise on the roentgenology of the digestive tract written from the standpoint of the clinical radiologist. Dr. Campo was the first gastroenterologist in Madrid to install an x-ray equipment. The authors utilize this means on a par with other clinical and biological methods of investigation; and an effort has been made, so the authors state in their introduction, to regard roentgenology as a laboratory aid and to utilize all other diagnostic means at the same time. They insist that they are not roentgenologists, because they have practiced roentgenology in connection with their specialty for a number of years, any more than they could be considered chemists because in their offices they analyze the gastric and other digestive juices. Nevertheless, in a large practice covering several thousand cases explored with the roentgen rays, the authors have accumulated a considerable experience in the roentgenology of the digestive tract. They therefore feel qualified to write this book in order to place before Spanish readers the summing up of the present day knowledge of this diagnostic means in diseases of the alimentary tract. They have evidently familiarized themselves with the most important literature on the subject, and free reference has been made to the standard works of American and European roentgenologists. The book is charmingly written and can be heartily recommended to the Spanish medical profession.

JAMES T. CASE.

TRANSLATIONS & ABSTRACTS

SIMMONS, CHANNING C. The Treatment of Carcinoma of the Skin with Radium. The Results of the Cases Treated at the Collis P. Huntington Memorial Hospital. (*Boston M. & S. J.*, Vol. XXXI, No. 16, October 16, 1919.)

The policy has been not to use radium in all cases of malignant disease applying for treatment but to advise operation if it seems best in a given case. In certain of the milder cases in which the growth is favorably situated, operation gives a better immediate result and a greater hope of permanent cure. In another class of advanced cases operation, to remove the greater portion of the growth, followed by radium treatment, is the treatment of choice. Most of the cases are suitable for radium treatment and can be divided roughly into two classes—those in which a permanent cure is to be expected and those in which the disease is extensive and in which radium is used as a palliative measure to retard the rate of growth.

Radium is particularly valuable in the treatment of skin cancer arising about the orbit. Less deformity of the lids results by the destruction of the growth in this manner than by operation, which can always be performed later if the radium treatment is unsuccessful.

On the other hand, in some cases, especially where the growth is situated about the ear or on the cheek, operation, followed by a plastic flap or skin graft, gives a better result.

A plastic operation for ectropion or deformity of the nose after the destruction of the growth by radium, but should not be attempted until all inflammatory reaction from the radium has subsided and sufficient time has elapsed to make the possibility of recurrence remote. Carcinoma arising on the tip of the ear responds very slowly to radium and operation is usually the treatment of choice, the resulting deformity being less noticeable than would be expected.

All patients should be warned of the possible depilatory effects of the radium, as the beard, eyebrows, or eyelashes may be unavoidably destroyed. Treatment inside the buccal cavity even will frequently destroy the beard. In treating carcinoma in the region of orbit, they should also be warned of the probability of conjunctivitis. A Wassermann test should be taken in all cases in which there is the slightest suspicion of syphilis, as the clinical diagnosis differentiating between rodent ulcer and syphilis is at times difficult. It must not be forgotten, however, that carcinoma can arise in a syphilitic ulcer, or that the two conditions may be coexistent and have no relation to each other.

It has been made a rule not to treat carcinoma of the lip with radium except in cases where operation is contraindicated on account of diabetes, high blood pressure, or the extent of the growth, as we consider operation the only proper treatment. We have seen cases in which a small carcinoma of the lip had been entirely destroyed by radium develop hopeless carcinoma in the glands of the neck a few months later. Keratosis of the lip, the precancerous condition, yields readily to radium, which is the treatment of choice.

Methods of Treatment.—The actual method of applying the radium for treatment varied greatly as to the type, situation, and extent of the growth. The usual procedure in the small superficial tumors in accessible regions was to fasten the glass tube containing the emanation, which was in turn enclosed in a steel needle, to the top of a metal cone 1 cm. in height, the diameter of which was slightly larger than the growth. The cone has a broad flange on the bottom which protects the surrounding skin from the action of the rays. The cone with the radium attached was then fastened over the growth and allowed to remain in place for from one-half to two hours. The usual dose was from 20 to 50 millicuries, although heavier treatments have recently been used. In growths about the scalp or orbit, sheet lead was also used as a protection to prevent loss of hair or conjunctivitis, which, in spite of all precautions, often follows the treatment of carcinoma of the lids. The average small growth usually disappeared in from two to four treatments, often in one, but the resulting superficial ulcer heals slowly. After the first treatment, patients report once in two weeks for observation and further treatment, as necessary. We have found that the best method of treating the superficial ulcers is to instruct the patient to bathe them once or twice daily with a solution of peroxide and water, equal parts, and keep them covered with white vase-

line or other bland ointment, on a piece of compress cloth.

In the large superficial growths the steel needles containing the radium emanations were usually laid directly on the growth in a series around it a short distance inside the edge. The bare glass tubes are also, at times, used in a similar manner, or raised up ½ cm. from the surface on a piece of gauze.

Fungoid growths, where there was considerable tumor tissue, were often treated by imbedding the glass tube containing the emanation directly in the tumor and leaving it *in situ*. One or more tubes containing from 5 to 12 millicuries were usually embedded in this manner.

In large growths on the cheek which have involved the bone and infiltrated the antrum much may be accomplished by removing the tumor by operation with the knife, curette, and actual cautery. A tube of radium may be introduced into the cavity thus formed in the gauze packing at the time of operation and left in place for from twelve to forty-eight hours, depending on the amount used. The deformity following these operations on the upper jaw is surprisingly little, considering their extent. Further radium treatments are given as indicated. The same procedure may be followed after eventration of the orbit for cancer, or, if there is a chance of all the growth having been removed, the radium treatment may be delayed until a recurrence appears.

All cases are requested to report at the hospital regularly for observation whether they need treatment or not. Cases which do not report are followed up at the end of six to twelve months from their last visit to determine their condition.

The 259 cases, for convenience of study, were divided into the following groups: Cancer of eyelids and about the orbit, 52 cases; cancer of the nose, 79 cases; cancer of the cheek, 71 cases; cancer of the forehead, 27 cases; cancer about the ear, 24 cases; miscellaneous cancer (hands, feet, etc.), 6 cases.

Of these cases 201 (77 per cent) had previously received some form of treatment. In some the growth had been destroyed but had recurred, while in others treatment had had little or no effect. Many patients had drifted from one physician to another and had tried several different remedies. Many of the methods of treatment employed are well recognized and it must be borne in mind that we only saw the unsuccessful cases and have no means of judging the numbers cured. A list of the more common methods employed is given below:

X-ray	61	cases
Violet light	4	"
Finsen light	1	"
Radium	11	"
Electricity	3	"
Operation	67	"
Cautery	13	"
Freezing (liquid air, etc.)	6	"
Cancer pastes	27	"
Ointments	44	"
Treated by many remedies	49	"
No previous treatment	56	"
No data	2	"

End-Results

No recurrence 1 year	8	cases	
No recurrence 2 years	14	"	
No recurrence 3 years	51	"	
No recurrence 4 years	22	"	
Recurrent cases	26	"	21.4%
Result unknown	3	"	

(Of the 26 recurrent cases, 13 yielded readily to further light treatment.)

Slesinger, *E. G.* Osteitis Fibrosa. *(The Lancet*, CXCVII, 5020. November 15, 1919.)

The condition known as osteitis fibrosa is now recognized to be a good deal commoner than was at one time supposed; but even at present some obscurity attaches to it, partly on account of the very mixed nomenclature under which it has been described in conjunction with several other entirely different diseases occurring in bone. A further difficulty arises from the fact that opinion appears to be still divided as to whether osteitis fibrosa, as it occurs in a single bone, and von Recklinghausen's multiple fibro-cystic disease of the bones, are or are not the identical disease. The study of these two diseases however, leads one to the belief that the conditions are unconnected, except in so far as in both there occurs a localized or generalized replacement of the bone marrow by a fibroid tissue. Further, von Recklinghausen's disease occurs as a rule fairly late in life, while osteitis fibrosa is essentially a lesion of the epiphyseal period.

Etiology—Opinion is fairly evenly divided between the views that (1) it represents a metaplastic transformation of the bone marrow into a fibroid tissue, and (2) that it is the result of a chronic inflammation of unknown origin occurring in the endosteum.

Bone Affected—Three of the long bones seem particularly liable to this condition,

namely, the femur, the humerus, and the tibia. Almost without exception all the cases in which the solid form of the disease has been observed have occurred in the femur. After the three bones mentioned above, the next most liable are the fibula and the phalanges. It does occasionally occur in other bones, but only very rarely.

Symptoms—The symptoms of this disease are essentially those of its complications and of the deformities that result from it, and the disease may be, and often is, present for a considerable time without sufficiently bothering the patient to force him to seek advice. Pain is very often absent until the onset of some complication, such as fracture; but some patients complain of aching in the bone, particularly at night.

The most helpful evidence from a diagnostic point of view is often given by the *x*-ray appearances. Expansion and thinning of the bone are most marked in those cases with cyst formation and the appearance of a clear space in the bone, crossed by a number of trabeculae, forms the usual pictures. The trabeculae, however, are no guide to the extent of actual cyst formation and may be as marked in the solid cases as in those in which a number of cavities are present. A further point noted in the *x*-ray plates is the tendency of the clear area to be prolonged down the shaft in a pointed extension in contrast to the usually rounded lower limit of a myeloma. The differential *x*-ray diagnosis between osteitis fibrosa, myeloma, other cyst-forming conditions, and some cases of tuberculous disease, is often difficult or even impossible.

Diagnosis—The diagnosis of osteitis fibrosa rests on its differentation from other conditions causing expansion of the bone during the epiphyseal period. Difficulty sometimes occurs in regard to tuberculosis, but in this condition the limitation of motion which occurs is in all directions, whereas in osteitis fibrosa it is merely that of the resultant deformity, and further in the latter condition it is rare to find pain. From myeloma or enosteal sarcoma the differential diagnosis is often extremely difficult, and here the *x*-ray examination is often of extreme value.

In many cases, however, the diagnosis can only be made at operation or even only after microscopical examination of the tissue removed. Even here difficulties sometimes occur, and cases are seen in which the cellular character of the tissue makes it difficult to be certain of the innocent character of the section. Indeed almost all stages, from a typical osteitis fibrosa to an equally typical fibrosarcoma, can be met with, and in doubtful cases only a guarded opinion from the pathologist point of view can be given. W. W. Belden.

THE AMERICAN JOURNAL OF ROENTGENOLOGY

Editor, H. M. Imboden, M.D., New York.

VOL. VII (NEW SERIES) FEBRUARY, 1920 No. 2

THE AVIATOR'S HEART. ROENTGEN RAY STUDIES UNDER CONDITIONS SIMULATING HIGH ALTITUDES*

By LEON T. LeWALD, M.D., (Late) Major, M. C., U. S. A.

Roentgenologist to the Medical Research Laboratory, Air Service, Mineola, L. I.; Late C. O. School of Military Roentgenology, N. Y. City; Professor of Roentgenology, New York University; Director Roentgen Dept. St. Luke's Hospital, and Gibbs Mem. X-Ray Laboratory.

NEW YORK CITY

And GUY H. TURRELL, M.D., (Late) Major, M. C., U. S. A.

Chief of the Cardiovascular Department, Research Laboratory, Air Service

MINEOLA, L. I.

DURING the examination of aviators under reduced atmospheric pressure (Fig. 1) in the low-pressure chamber at the Medical Research Laboratory at Mineola, N. Y., Major James L. Whitney, M. C.,[1] and his co-workers had observed at pressures corresponding to altitudes of 18,000 or 20,000 feet an increase in the area of cardiac dullness in the case of certain aviators. Later, a similar increase in the cardiac dullness was occasionally observed during the course of the low oxygen test, conducted at the laboratory for the purpose of classifying aviators according to their ability to withstand the effects of high altitudes. The enlargement as observed by Whitney was principally to the left, but occasionally right-sided enlargement was encountered in addition (Fig. 2). Whitney ascribed the increased area of dullness in these cases to dilatation of the heart, and thought that it was due partly to fatigue, such as occurs after excessive exertion, as in Marathon runners, and partly to lowered tonus of the heart muscle arising from the lessened oxygen content of the inspired air and of the blood.

The present studies were undertaken to determine whether cardiac enlargement actually does occur under these circumstances; and if it does, what is its amount; whether its onset is sudden or gradual; what is its relation to the blood pressure and to the psychomotor reactions of the aviator; and whether it is a conservative process designed to increase the output of blood by the heart, or whether it is a true dilatation due to fatigue or exhaustion of the heart muscle.

Two series of studies were planned; one with the Henderson rebreather, and the other in the low pressure chamber. The rebreathing experiments were undertaken first, because any changes observed would almost surely be due to diminished oxygen alone; whereas, in the low pressure chamber they might be influenced by the change in pressure or by the expansion of abdominal gases causing an upward displacement of the diaphragm.

The Henderson rebreather (Figs. 3 and

[1] "Medical Studies in Aviation," *J. Am. M. Assn.*, Oct. 26, 1918.

*Read at the Twentieth Annual Meeting of THE AMERICAN ROENTGEN RAY SOCIETY, Saratoga Springs, N. Y., September 3-6, 1919; at the Medical Section, N. Y. Academy of Medicine, June, 1919, and also in abstract at the American Association for Thoracic Surgery, June 9, 1919.

4) consists of an iron tank of about 60 to 100 litres' capacity, provided at the top with a water-sealed spirometer, and connected through tubing with a mouth-piece through which the subject breathes. The nose is clamped with a spring "clothes-pin," so as to close the nostrils tightly. An arrangement of two mica check-valves causes the inspired air to flow through one tube, and the expired air to flow through the other back into the tank. The expiratory tube has inserted in its course a cartridge containing "shell" potassium hydroxide to absorb the exhaled carbon dioxide. As the subject of the experiment breathes the air in this tank over and over, he gradually uses up the oxygen until finally he may come to a point where he is breathing an oxygen-nitrogen mixture containing only 8, 6 or even 5 per cent of oxygen instead of the usual 21 per cent in normal air. Since the nitrogen is bland and neutral (simply a vehicle, as it were, for the administration of oxygen) the effect of diminishing the percentage of oxygen in the rebreather has the same physiological effect as rarefying the air in a low-pressure chamber, or ascending to a high altitude. In either case, the actual amount of oxygen available for the blood in a given four litres of lung capacity becomes progressively less as the experiment proceeds or as higher altitudes are reached.

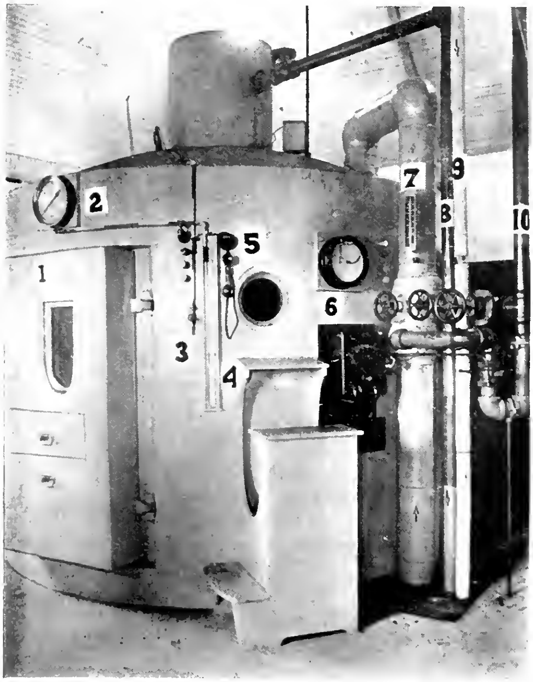


Fig. 1. Low Pressure Tank used in Study of the Aviator's Heart.

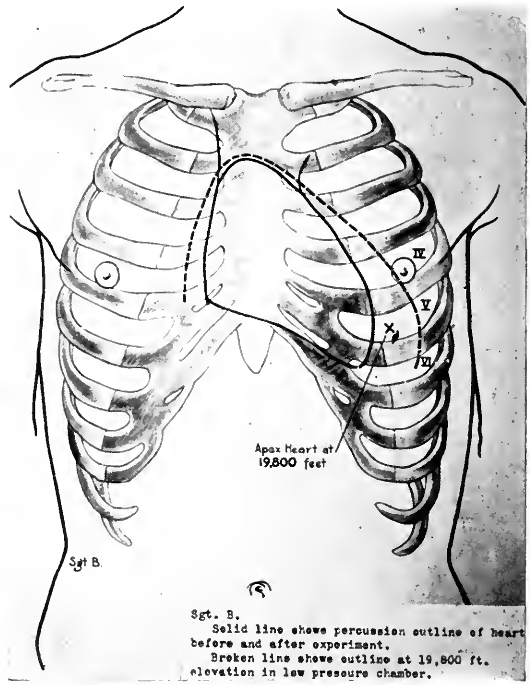


Fig. 2. Cardiac Enlargement to both Right and Left as Determined by Percussion in the Low Pressure Chamber. (Whitney.)

In our first series of observations, roentgenograms were made of aviators every five minutes while they were in the rebreathing apparatus. The length of the run on the rebreather varied from fifteen minutes to thirty-eight minutes. With the controls taken before and after the run, there were obtained from six to thirteen roentgenograms of each heart.

The greatest care was taken in the alignment of the tube, the patient, and the plate, so as to make the radiographs properly comparable one with another, not only those of the same, but also those of different subjects. The sitting posture offered the most advantages, as not interfering with the rebreathing apparatus, and also as enabling the sub-

jects to maintain a fixed position for the required length of time. In order to make sure that the alignment was maintained throughout the experiment, a special chair was built having a straight back containing a large transparent celluloid panel. Down the center of the back a perpendicular line was drawn and divided off into inches to indicate the distance above the floor, so that the target of the x-ray tube could readily be adjusted to any required height to correspond with the point selected on the back of the subject. As a means of detecting change of position and of recording it on the plate, if it occurred, a distinctive metal marker was placed on a given posterior spinous process, and another upon the sternum. After several trials, a small metal washer of about ½ inch diameter, fixed by adhesive plaster over the spinous process of the 7th dorsal, and a straight lead rod, 2 or 3 inches long, down the center of the sternum, were found to be very satisfactory. The displacement of their shadows laterally, or upward or downward, served to indicate the slightest change in the alignment and in the posture of the

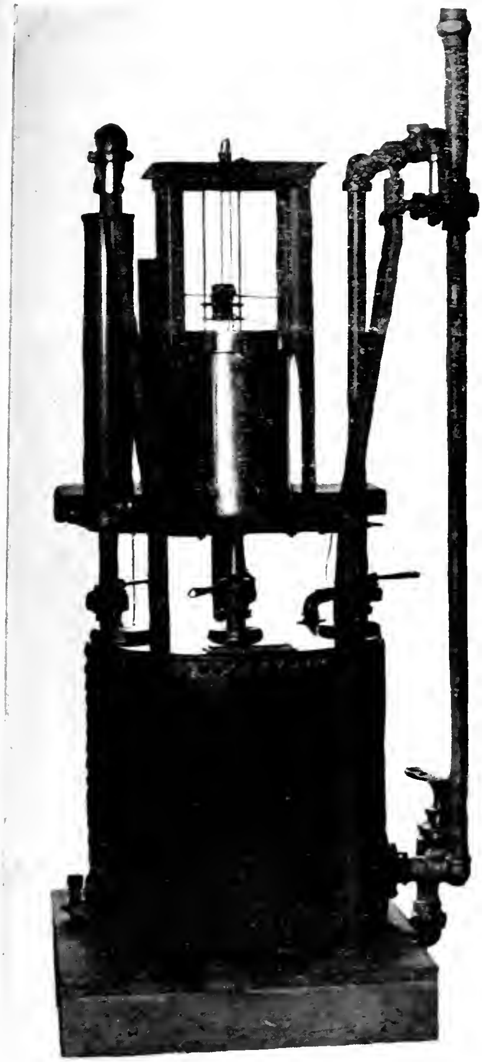
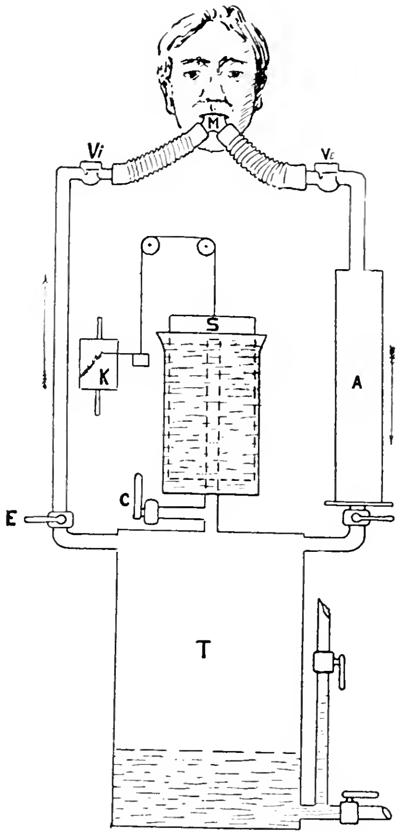


Fig. 3. The Henderson Rebreather.



The rebreathing apparatus employed in all routine tests of the aviators' ability to withstand low oxygen. It consists of a tank, *T*, of about 120 liters capacity. The volume of air is determined by the amount of water that is run into it. The man under examination continually rebreathes the air of the tank (a clip is placed on his nose) through the inspiratory and expiratory valves, *Vi* and *Ve*. The oxygen is thus consumed and reduced. The exhaled carbon dioxid is taken up by sodium hydroxid in the absorber, *A*. The movements of respiration are recorded by the spirometer, *S*, connected to a smoked drum, *K*. As the oxygen is consumed and the air volume is thus reduced, the spirometer falls and the graphic record on the smoked drum rises. At the end of the test a sample of air is drawn from the tank and analyzed as a confirmation of the oxygen consumption and of the oxygen percentages (that is, altitudes) indicated by the graphic record.

Fig. 4. Diagram of the Henderson Rebreather.

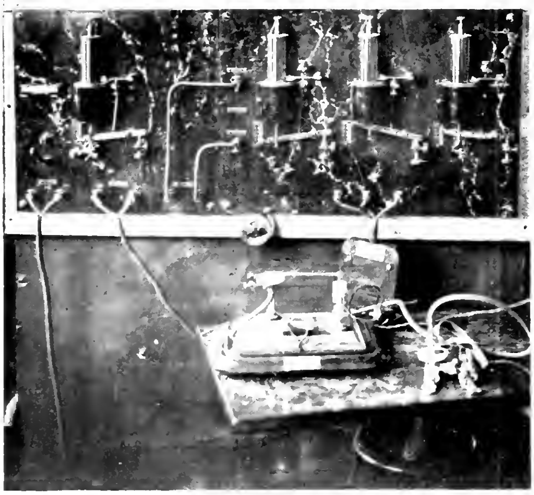


Fig. 5. Timer to set off the X-Ray Exposure in Relationship to the Pulse. Specially devised switch activated by the pulse seen in foreground.

subject. In a few studies of the movements of the diaphragm, each nipple was marked with a small lead circle, and the apex by a cross.

Teleroentgenograms were made at a 2 m. distance and were taken during both inspiration and expiration. Serial radiograms were made at a 75 cm. distance in both expiration and inspiration, and in certain instances double exposures on one plate were made to show both inspiration and expiration. The shorter distance was adopted for convenience as being the least possible for working through the aluminum window of the low pressure chamber. In view of the danger of implosion, this window was made of pure aluminum 15 mm. in thickness. (Figs. 7 and 8.)

The exposures varied from 1/20 to 3/20 of a second at the 75 cm. distance, and from 1/10 to 3/5 of a second at the 2 m. distance. In the series on the rebreather the double exposures were most successfully obtained with that in expiration given 3/20 of a second, and that in inspiration given 1/15 of a second. Short and practically instantaneous exposures were necessary during the rebreathing tests, because it is impracticable to have the subject hold his breath at the lower oxygen percentages. Holding the breath under these circumstances is liable to produce dizziness and fainting, or other symptoms of oxygen want in the brain.

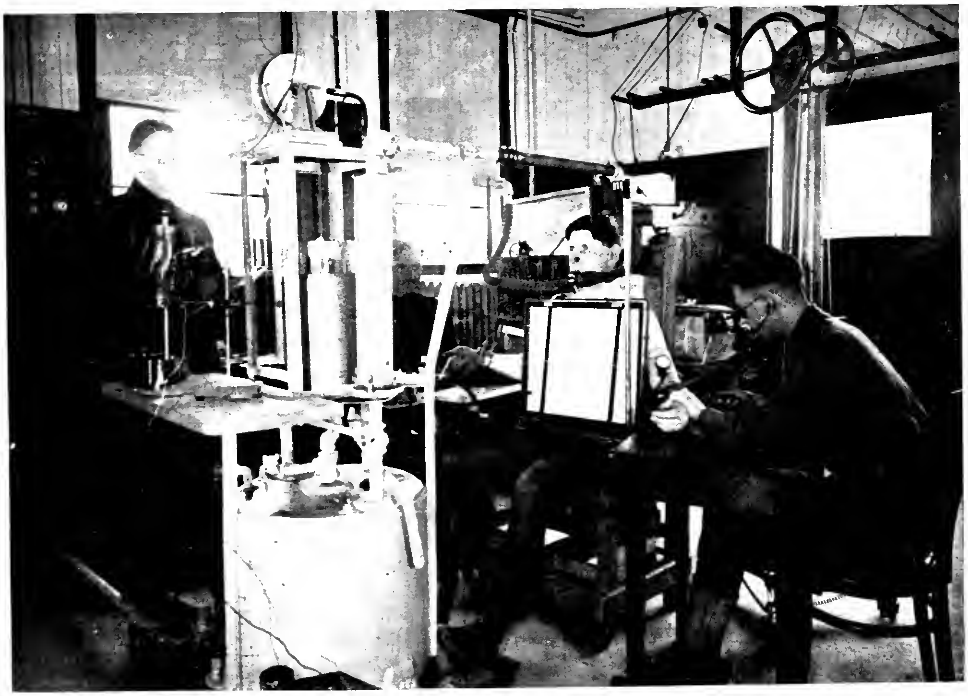


Fig. 6. Roentgenogram Being Taken in Conjunction with Rebreather, etc.

In the low pressure chamber, exposures were made through the aluminum window at the 75 cm. distance in 3/20 of a second. Single rapid intensifying screens were used in all exposures. The exposures were made on x-ray plates of standard makes issued by the army. The plates were developed by the tank method, with Eastman x-ray developer. The transformer was one of the Base Hospital types issued by the army. The exposures were timed by a special timer, depending upon the principle of falling weights, its correctness having been checked by stop-watch and metronome. Because of the shortness of the exposures, it was thought necessary to time them for a definite period of the cardiac cycle, in order to avoid possible variations in size due to systole and diastole. The timer was therefore actuated by a special mechanism set off by the pulse wave (Fig. 5). This was merely an adaptation of the wrist piece and tambour of the Mackenzie polygraph, with the writing arm equipped with a platinum end that dipped into a mercury cup to close the electric circuit which actuated the timer. The timer could be set to make the exposure with the pulse beat or at definite fractions of a second after the pulse (Fig. 17). In

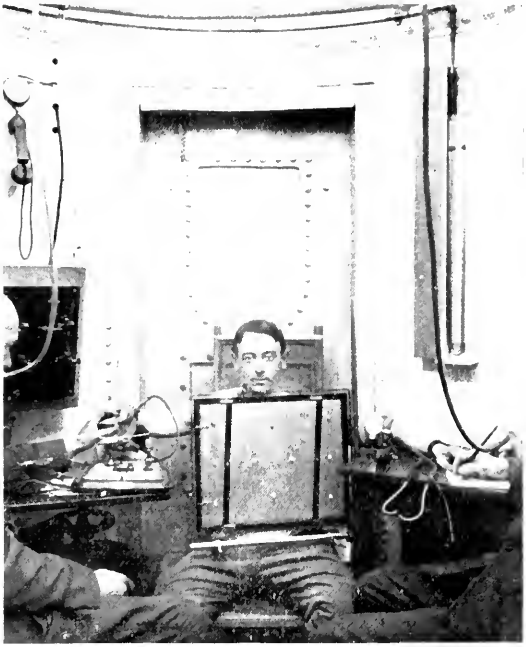


Fig. 7. Roentgenogram Being Taken in the Low Pressure Chamber through the 15 mm. Aluminum Window.

our serial plates with the rebreather, the exposures were timed to be synchronous with the diastolic phase of the heart cycle.

A record of the respiratory phase of the exposure was made by means of a perforation of the kymograph tracing by a high

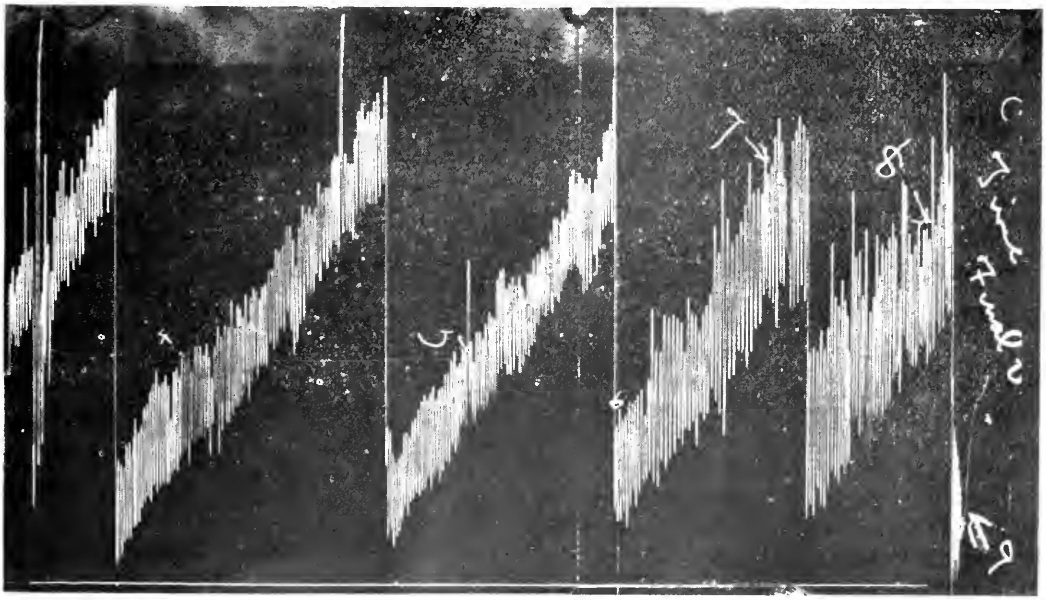


Fig. 8. Kymograph Tracing. Case 142. Note at the beginning the irregularity of the respiratory curve (psychic), and toward the end the greatly increased depth due to oxygen want.

tension spark. This spark was obtained by shunting off through resistance a small amount of current from the primary terminals of the *x*-ray transformer, and then stepping it up to a high tension and passing it through a small Leyden jar as a condenser. (Figs. 6 and 8.)

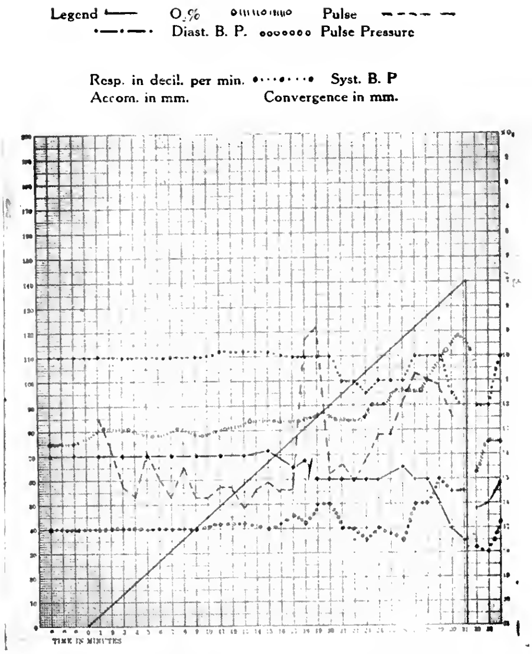


FIG. 9. CASE 142. CHART SHOWING CIRCULATORY FAILURE. MODERATE RESPIRATORY EMBARRASSMENT.

The pulse rate, systolic and diastolic blood pressures, were taken every other minute until the fifteenth minute, after which time they were taken every minute. A record of the volume of air inspired per minute was also kept. (Fig. 9.) All of our subjects were healthy aviators, ranging in age between twenty and forty-two years.

In the very beginning of our work it became evident that different silhouettes of the same heart varied greatly in form and in measurement of the transverse diameter (Fig. 17). As the tube distance, position of the subject, and the alignment remained the same, it was evident that the cause was some change taking place in the subject himself. After a series of radiographs it appeared that the preliminary controls taken during forced held inspiration showed a narrower heart than any of those taken during the course of the rebreathing tests. We then took an extra plate during forced held expiration, and found that these gave a broader shadow than those taken during the course of the rebreathing.

By superimposing a silhouette taken in *expiration* upon one from the same subject taken in *inspiration* (Figs. 11 and 12), so that the shadows of the metallic markers upon the backs coincided and the shadows of the vertical rods on the sternum were parallel, the changes taking place in the shape and position of the heart during deep respiration could be readily seen. It should be borne in mind that every exposure in each series was made during the same phase of the cardiac cycle. This was usually one-fifth of a second after the pulse wave arrived at the wrist, but some were set off at the moment of the pulse beat. In either case it is presumed that the heart outline is that of diastole.

By this method of superimposing plates the excursion of the diaphragm upward in *expiration* was readily demonstrated, and the simultaneous lowering of the apex of the thoracic cavity was indicated by the lower position of the clavicles and of the sternal marker. This was only a different way of demonstrating facts already well known; but the changes in the mediastinal contents

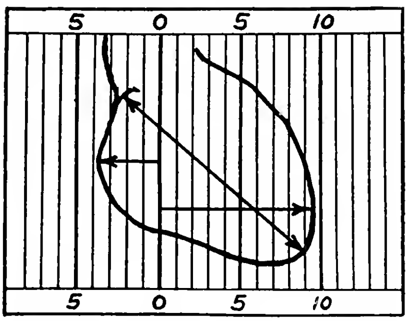


FIG. 10. USE OF TRANSPARENT SCALE FOR QUICK MEASUREMENT OF THE SIZE OF HEART SHADOW. The transverse diameter is instantly read off as 13.25 cm.

were to us rather surprising. This method was supplemented and the results verified by making two exposures of the same subject on one plate (Figs. 13 and 14).

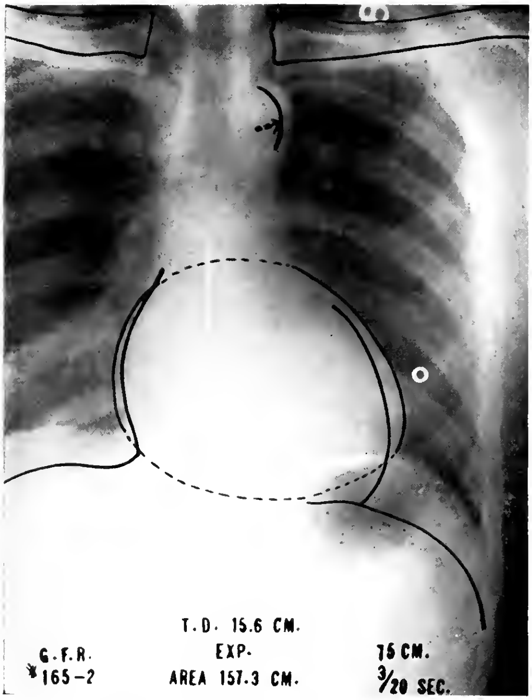


FIG. 11. HEART IN INSPIRATION AND IN EXPIRATION OUTLINED AFTER THE METHOD OF BARDEEN AND THE PLATES THEN SUPERIMPOSED. Change of Position of the Heart and Increased Prominence of Position of the Aorta Indicated. Position of the Clavicles during Inspiration Outlined.

The lifting of the apex and the broadening of the transverse diameter of the heart during expiration have been recognized by amount of this change does not seem to have been fully realized. Furthermore, most authorities speak only of left-sided displacement and apparent enlargement; whereas our results show in many cases decided broadening of the heart shadow toward the right as well as toward the left. The result is a marked increase in the transverse diameter. In several cases this increase amounted to over 3 cm. If radiographs should happen to be taken of the same heart at different times and in different phases of respiration, such differences in the transverse diameter of the shadow might easily be misleading and be the cause of a mistaken diagnosis of enlargement of the heart.

Our results would seem to show that during normal quiet respiration the changes in the transverse diameter are comparatively small, notwithstanding a fairly large excursion of the diaphragm (Fig. 13). We would explain this by the fact that the chief movement of the diaphragm in quiet breathing is in the two domes on each side of the central tendon, while the tendinous portion under the heart itself remains comparatively quiescent. Moreover, the slant of the portion of the diaphragm beneath the heart downward and forward is little changed in ordinary breathing. But in forced breathing the sulcus formed between the diaphragm and the anterior chest wall, which is partly filled by the lower border of the heart is obliterated during inspiration by the flattening of the whole diaphragm. During expiration the sterno-phrenic sulcus is rendered so sharp and thin by the rounding up of the diaphragm that the heart is squeezed upward. Conversely, the apex of the thorax and of the mediastinal space is lowered with the fall of the ribs and sternum in expiration, and raised in inspiration.

The resulting approximation of the apex and base of the mediastinal space during *expiration* thus tends to squeeze the contained organs outward and to broaden their

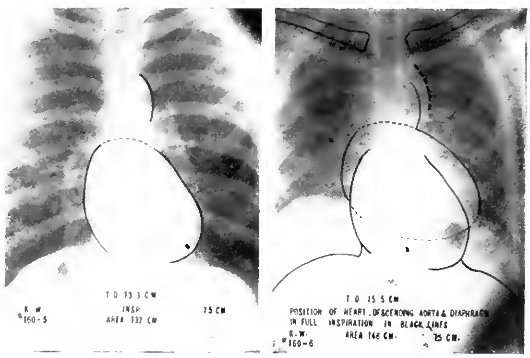


FIG. 12. AT LEFT OUTLINE OF HEART, AORTA AND DIAPHRAGM DURING INSPIRATION. AT RIGHT OUTLINES IN EXPIRATION, WITH THE INSPIRATORY POSITION SUPERIMPOSED AND DRAWN IN BLACK. Position of the clavicles in inspiration also drawn in black. The outline of the lead markers by means of which the plates were centered, are not shown in these reproductions.

shadows. The lengthening of the thoracic cavity during *inspiration* tends to stretch out the contained organs and to narrow their shadows. That this is no mere theory but does actually occur is shown by the increase

during expiration of the transverse measurements of the mediastinal silhouette at all levels. As in the case of the heart, it is also shown by making two exposures of the thorax on the same plate, one during expiration and one during inspiration. (Fig.

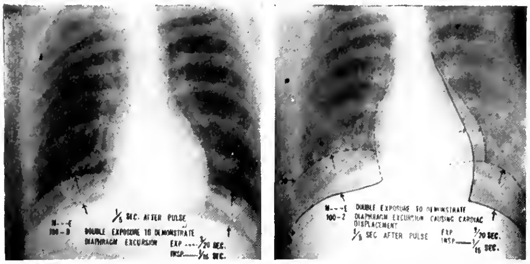


FIG. 13. TWO EXPOSURES ON ONE PLATE. MODERATE EXCURSION OF THE DIAPHRAGM (LEFT HAND PLATE.) PRODUCES SLIGHT BROADENING OF THE TRANSVERSE DIAMETER: A GREATER EXCURSION CAUSES INCREASE IN THE TRANSVERSE DIAMETER (RIGHT HAND PLATE).

14.) The apparent broadening of the aortic arch, especially its displacement to the left, is very noticeable in such plates. Two radiographs, such as those shown in Fig. 14, diameters in forced inspiration and forced expiration in atmospheric air was 3.3 cm. at if taken several months or years apart might

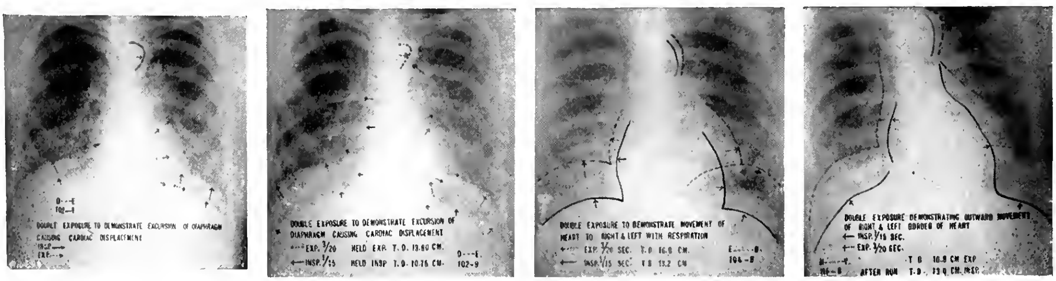


FIG. 14. EXAMPLES SHOWING TWO EXPOSURES ON ONE PLATE TO DEMONSTRATE RESPIRATORY DISPLACEMENT OF THE HEART DURING DEEP BREATHING.

easily lead to a serious mistake in diagnosis.

Out of a series of plates of 89 men, the largest difference between the transverse 75 cm. distance. The average variation was 1.37 cm. One heart showed no change in the transverse diameter—a case of valvular disease measuring 17.5 cm. at 2 metre distance.

During the course of the rebreathing tests of the same 89 aviators, the greatest variation in the transverse diameter in any one man was 3.5 cm., and the smallest variation was 0.15 cm. The average difference was 0.47 cm. at 75 cm. distance.

While the variations in the transverse diameter of the heart during the rebreathing test averaged less than those caused by forced inspiration and expiration, yet they may occasionally be even greater. The reason for this is that the rebreathing test produces forced breathing in certain aviators. In the early stages there is frequently irregular breathing due to excitement, but during the latter half of the run the respiration is normally very much deepened. It seems possible that this deepening results from an increase at both ends of the respiratory movement. Expiration as well as inspiration is exaggerated. This would seem to be shown in many of the respiratory kymograph tracings, where the expiratory curve occasionally goes below the average level of the expiratory excursion (Fig. 8). The same changes in the respiratory movement occur in the low pressure chamber or during an ascent to a high altitude as in the rebreathing test. There is an increase in the volume of air breathed per minute, and this increase in the minute volume results from deep breathing much more than from an accelerated rate.

Practically we found it extremely difficult, or even impossible in many cases, to time our exposures with any desired phase of respiration. Watching the kymograph drum one frequently would snap the switch at what one thought was the height of inspiration, and the next pulse beat would set off the exposure; but the subject would go on

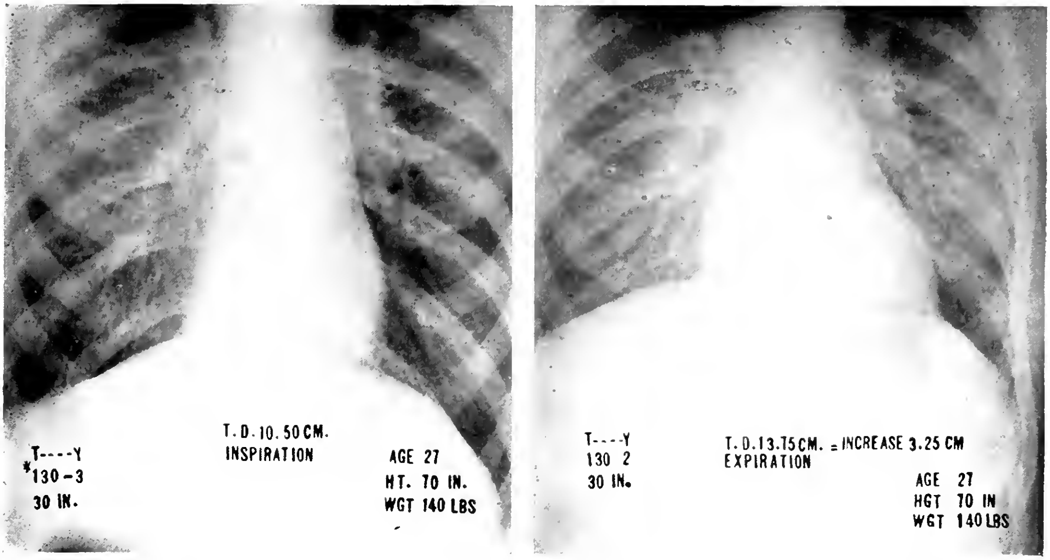


FIG. 15. THE SAME HEART IN INSPIRATION AND IN EXPIRATION. CHANGE IN TRANSVERSE DIAMETER 3.25

taking a long breath, and we would really have a radiograph taken in mid-phase respiration; or sometimes the electric connection would not be made in the mercury cup until the expiratory movement had begun, or even been completed. Such irregularities in the depth of respiration are indicated in the kymograph tracings of cases 110, 142, 116, shown in Fig. 8. The clinician in palpating and percussing the præcordium will detect the upward and outward position of the left border during expiration, and will probably fail to notice its return downward and inward during inspiration. A diagnosis of cardiac enlargement would be obvious and natural under such circumstances.

It seemed to us that this might be the explanation of Whitney's findings (Fig. 2). The similarity of his drawings of the heart outlines, as obtained by percussion, and those obtained by us by two exposures on the same plate is very striking. (Figs. 13 and 14.) It therefore seemed essential that the respiratory phase should be taken into account in our study of heart measurements.

In the low-pressure chamber, the expansion of the intra-abdominal gases which accompanies reduction of the external pressure, is frequently very troublesome both to the subject and to the observer. It would tend to increase the upward move-

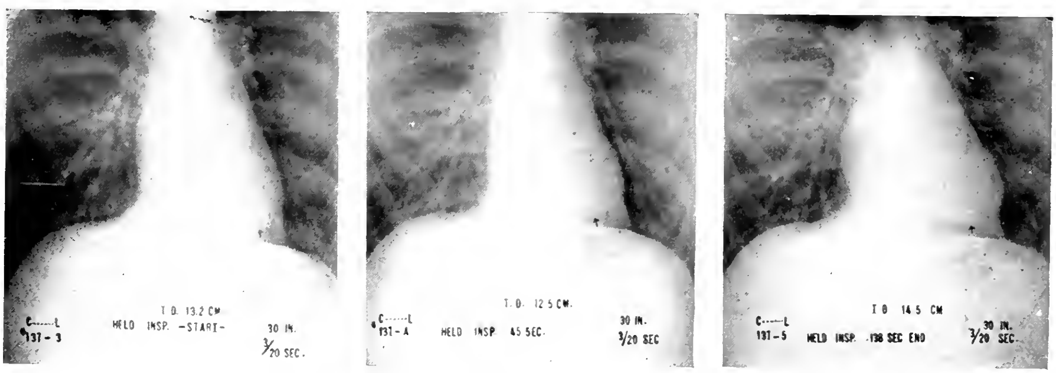


FIG. 16. INSPIRATION HELD 138 SECONDS. Note changes in the outline of the heart and position of the diaphragm, indicating the variation which may be obtained in the heart outlines during prolonged holding of the breath.

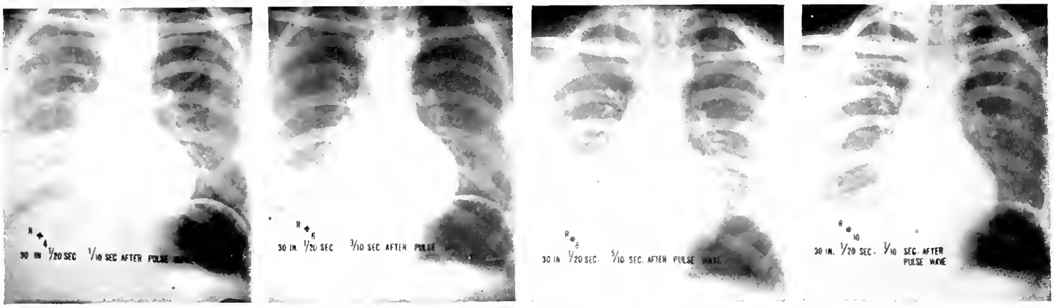


Fig. 17. Heart Cycle with Alternate Exposures made at Intervals of 1/10 sec. after Pulse Wave. Exposure time 1/20 sec. Target Distance 75 cm.

ment of the diaphragm in expiration, and to exaggerate the cardiac displacement. We should therefore expect to have an increase in the transverse diameter of the heart occur more frequently in the low-pressure chamber than with the rebreather.

Turning again to the heart shadows of the 89 aviators, we can readily divide them into three classes. The first class includes 66 subjects and comprises those in which no enlargement of the heart occurred under lowered oxygen pressures. While marked variations in the transverse diameter in the different plates occurred in a considerable proportion of these men, the changes were distributed so irregularly throughout the run, that they could not be attributed to oxygen want or to the progress of the test. In no case was the enlargement at the end of the run. (Fig. 19.)

The second class includes 9 cases which showed a more or less consistent increase in the transverse diameter toward the end of the test (Fig. 20). The greatest increase was 1.4 cm., and the least 0.2 cm. The average change was 0.75 cm. Careful study of the position of the diaphragm and of the respiratory phase at which the plate was exposed showed at once that in six of these cases the enlargement was merely expiratory displacement. For example, in case 152 the increase of the transverse diameter of the

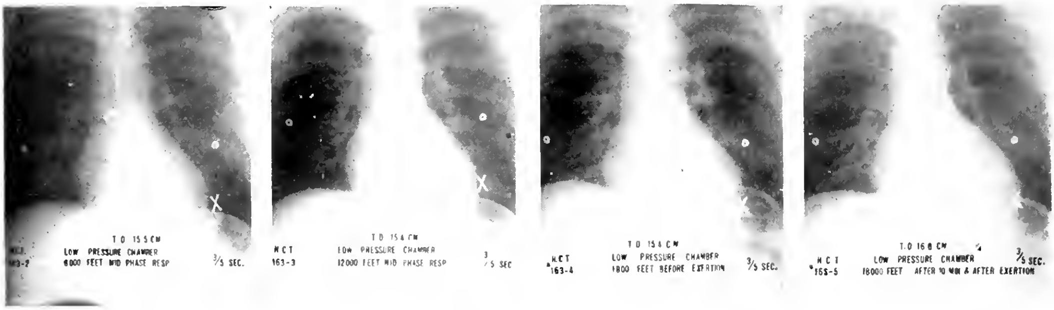


Fig. 18. Heart Outlines Taken in the Low Pressure Chamber. Note the apparent enlargement after exercise at a pressure corresponding to 18,000 feet.

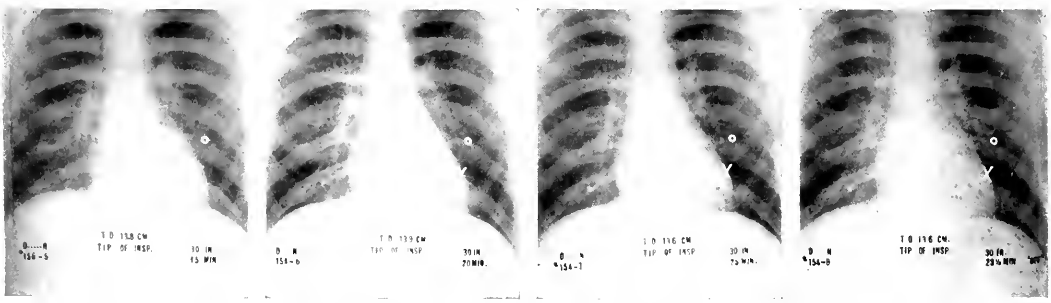


Fig. 19. Series of the Heart during Rebreathing Test. All obtained at the tip of inspiration and showing no change in the transverse diameter.

heart silhouette was 1.25 cm. At the time of this increase the shadow of the diaphragm had moved upward a distance of 4.5 cm. from its position in the preceding plates. That is, it had moved from 7 cm. below the left nipple and 5 cm. below the right nipple (its position in inspiration) to 2.5 and 1.5 cm. from the respective nipples.

Again, in Case 37, the 1 cm. increase occurred at the twenty-fifth minute of the run, at the time of psychomotor inefficiency phase at the moment the exposures were made.

In the other three cases, the increase was 0.4 cm. or under, and is not explained by the expiratory position of the diaphragm. In cases 90 and 185, the increase is only 0.2 cm. and was regular and progressive from start to finish. The systolic pressure in Case 125 increased during the rebreathing test from about 130 to 144 mm., while the diastolic dropped from 70 to 40 mm. The pulse

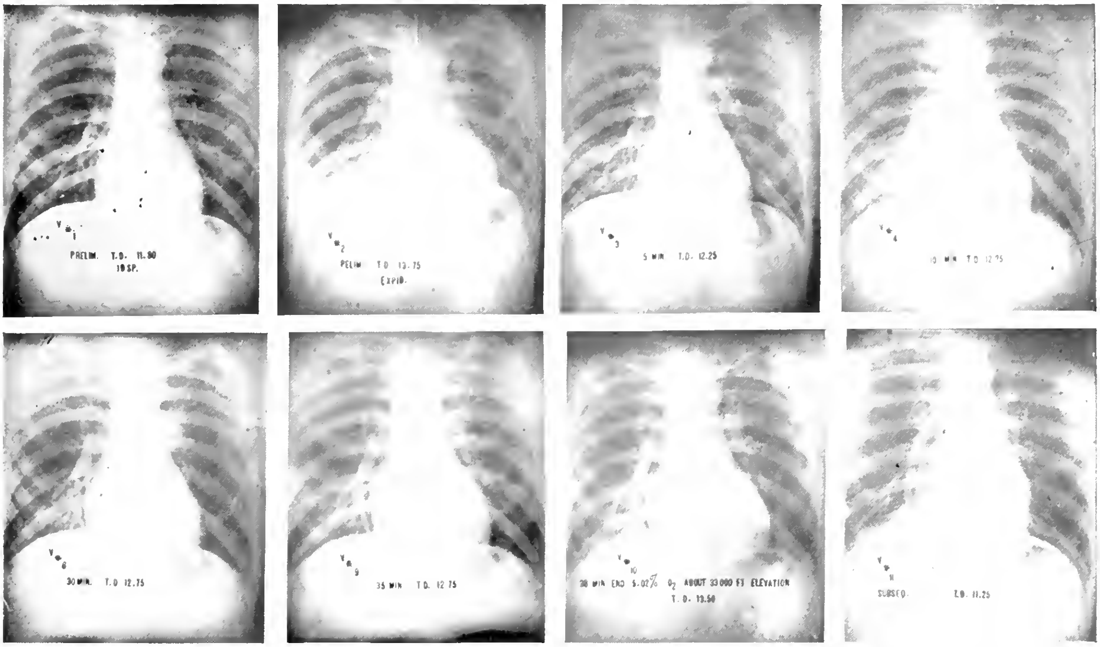


Fig. 20. Apparent Enlargement of the Heart During Rebreathing Test. The heart outline at 38 minutes (oxygen diminshed to an extent corresponding to an altitude of about 33,000 feet) shows a transverse diameter of 13.50 cm. with the diaphragm at a somewhat higher level than in any of the preceeding exposures during the run.

when the subject was sitting rigid in the chair. The radiograph shows the diaphragm in the position of expiration. The blood pressures were practically unchanged. The systolic ranged between 110 and 120, with the terminal at 112. The diastolic varied between 64 and 72, the final reading being 64. The pulse rate was not unduly accelerated. In short, there were no evidences of heart strain. We do not believe the diagnosis of dilatation justified in these two cases. Similarly the enlargement of the transverse diameter in cases 21, 32, 40 and 77, is explainable by variations in the respiratory pressure ranged from 60 in the beginning to 104 at the end. The pulse rate increased from 90 to 112. The subject at the end was still conscious but showed muscular twitching and motor inefficiency.

Case 90 shows a slight increase in pulse pressure at the end of the run (from 35 to 49 mm. Hg.). The pulse rate accelerated from 90 in the beginning to 117 at the end.

It is possible that the increased transverse diameters in these two cases represent actual enlargement of the heart. If such is the case, it could possibly be explained by the diminished tenus of the cardiac muscle brought

about by oxygen want. This would perhaps account for the greatly increased pulse pressure, which was produced partly by increased output of blood at each cardiac systole, and partly by the increase in the rate of the beat. The final result would be a greatly increased output of blood per minute. Since the increased pulse pressure in both cases is due to lowering of the diastolic pressure together with a slight increase in the systolic pressure without any other sign of heart strain, we are inclined to consider such an enlargement of the heart, if it occurs, a conservative process designed to compensate by increased circulation for the lessened oxygen content in the blood.

In the third subject, Case 110, the increase in the transverse diameter was 0.4 cm. It is accompanied by a slightly higher position of the diaphragm. This case is noteworthy because the increase in the transverse diameter was accompanied by a rise of the respiratory volume from 65 decilitres per minute in the beginning, to over 200 decilitres per minute at the end. The respiration was principally deepened. There was little increase in the rate. We will mention later another case in which this respiratory phenomenon was the noticeable feature, but in which the final transverse diameter in the run became smaller. It scarcely seems possible that carbon dioxide retention of elimination can explain these two opposite reactions.

The third class of cases includes those in which there was a *decrease* in the transverse diameter. In some subjects the decrease was gradual and progressive during the test; in others it was a sudden diminution at the end. Analyzing them according to their probable causation, we may divide these also into three varieties or groups.

The first group includes those in which the changes are evidently due to varying phases of respiration at the moment of exposure. Cases 51, 82, 114, 121, 139 and 151 are explainable in this way. All of these subjects really belong to the class of cases in which there was no significant change in the transverse diameter, or rather the class in which the change in the transverse diameter represents a displacement rather than a true enlargement of the heart.

The second variety of cases showing diminution of the transverse diameter, includes five subjects (Table 1) all of whom showed symptoms of circulatory failure at the end of the rebreathing test.

Case 53 went to 9.5 per cent of oxygen in 27 minutes and 50 seconds. His systolic blood pressure remained constant at about 120 mm. of mercury until the twenty-sixth minute, when it fell suddenly to 80 mm. at the twenty-seventh minute. The diastolic began at about 78 mm. and rose somewhat irregularly to 88 mm. at the twenty-fifth minute. During the next two minutes it fell to 42 mm. of mercury. The pulse pressure remained fairly constant around 35 mm. during the run; but

TABLE 1

CLASS III, GROUP 2.—Transverse diameters and areas of the heart silhouette made at 75 cm.

Exposure	Case 53		Case 122		Case 144		Case 142		Case 83	
	T. D. (cm.)	Area (sq. cm.)	T. D. (cm.)	Area (sq. cm.)	T. D. (cm.)	Area (sq. cm.)	T. D. (cm.)	Area (sq. cm.)	T. D. (cm.)	Area (sq. cm.)
1	15.4	175	14.7	142	11.8	136	16.	162	13.4	150
2	14.5	161	15.5	142	12.	139	15.7	156	12.75	145
3	14.6	165	14.5	136	12.5	138	15.5	160	13.	144
4	14.5	165	14.9	137	12.4	144	15.8	150	12.8	143
5	..	...	15.2	142	12.	127	14.4	161	13.1	149
6	...	...	14.1	135	....	...	....	...	.....	...
Av. in run	14.7	166	14.9	13.9	12.1	137	15.3	157	12.85	146
End of run	11.9	135	13.8	110.	11.3	116	14.4	142	12.	132
Prelim. (insp.)	13.5	149	Double	Exposure	11.9	138	13.5	152	12.5	144
Post. (insp.)	13.5	160	14.4	Double Ex.	11.4	129	13.8	150	13.	148

Note. The numbered exposures are those made during the rebreathing test. They were made approximately five minutes apart, except that at the "end of run" which was made as nearly as possible at the moment of the termination of the test. Estimation of the area is usually uncertain in double exposures. The figures are not entered in such cases.

after the subject was removed from the rebreathing machine it went down to 20 mm. at the thirty-second minute. The pulse rate remained between 70 and 75 for ten minutes, and then rose gradually to 108 at the end of the test. At the twenty-seventh minute the subject lost consciousness in a typical vaso-motor faint. As is shown in Table I, the transverse diameter remained at about 14.5 cm. to the twenty-fifth minute. At the twenty-seventh minute, at the moment of the faint, it was 11.9 cm. We believe that this sudden diminution of the transverse diameter was caused by dilatation of the splanchnic vessels, so that the venous pressure was not sufficient to fill the heart during its diastolic relaxation. The roentgenogram shown at the moment of the faint is therefore that of an empty heart.

In this case the high position of the shadow of the lead line on the sternum as compared with the "O" over the dorsal spinous process is due to a straightening of the upper dorsal spine and an elevation of the sternum which accompanied the falling backward of the head at the moment of the faint. Comparing the lateral displacements of the dorsal and the sternal marker in radiographs obtained before the run, at the moment of the faint, and after recovery from the faint, it is evident that there was no rotation at the time of the faint. The position of the diaphragm is not shown in as full inspiration at the time of the faint as it is in the preliminary plate or in that after recovery. Neither respiratory phase nor rotation of the body of the subject at the time of fainting will account for the suddenly decreased transverse diameter of the cardiac shadow. The evidence seems fairly conclusive that a sudden paralysis of the splanchnic vessels formed a large reservoir into which the blood was drained away from the peripheral vessels. As long as this drain merely removed blood from the arteries without too greatly lowering the venous pressure, there was a lowering of both systolic and diastolic pressures with little change in the pulse pressure. But as soon as the venous pressure was markedly lowered and the cardiac output per minute was diminished, the pulse pressure was lowered, and fainting supervened. Judging by analogy with other cases where it was possible to obtain it, the pulse pressure in case 53 was much lower at the time of the loss of consciousness (cf. *Air Service Medical,* 1919, No. 144, opp. page 225.). As the vena cava began to fill up again and the heart to obtain more blood to pump, the diastolic pressure would first be raised. Unless there was a simultaneous contraction of the arteries, there would result a lowering of the pulse pressure, coincident with an improvement in the blood supply to the brain and a return to consciousness.

Case 122 ran thirty-six and a half minutes, at which time he was breathing air containing only 5.2 per cent oxygen. He was then cyanotic and unconscious, but not relaxed. There were moderate convulsive twitchings of the hands, face, and head. The systolic blood pressure rose from 130 mm. at the beginning to 150 mm. at the thirty-third minute. The diastolic gradually fell from about 80 to 46 during the same period. The pulse pressure increased steadily from 50 mm. to 104 mm. at the thirty-third minute. Surely here, if ever, we would expect to find evidences of heart strain and dilatation. Plates exposed at the twenty-fifth and thirtieth minutes, at the height of inspiration showed transverse diameters of 14.9 cm. and 15.2 cm. The thirty-four minute plate, taken also at the tip of inspiration, shows a transverse diameter of 14.1 cm. At this point both systolic and diastolic pressures were falling. The thirty-six and a half minute plate was taken in full expiration. It showed a transverse diameter of only 13.8 cm. The kymograph tracing showed a marked increase in the depth of the respiratory movement during the last ten minutes of the run. We believe the first decrease in the transverse diameter to be attributable to this cause. The respiratory-minute-volume remained below 70 decilitres until the twenty-fifth minute, but increased rapidly thereafter to 165 decilitres. The second decrease in the transverse diameter

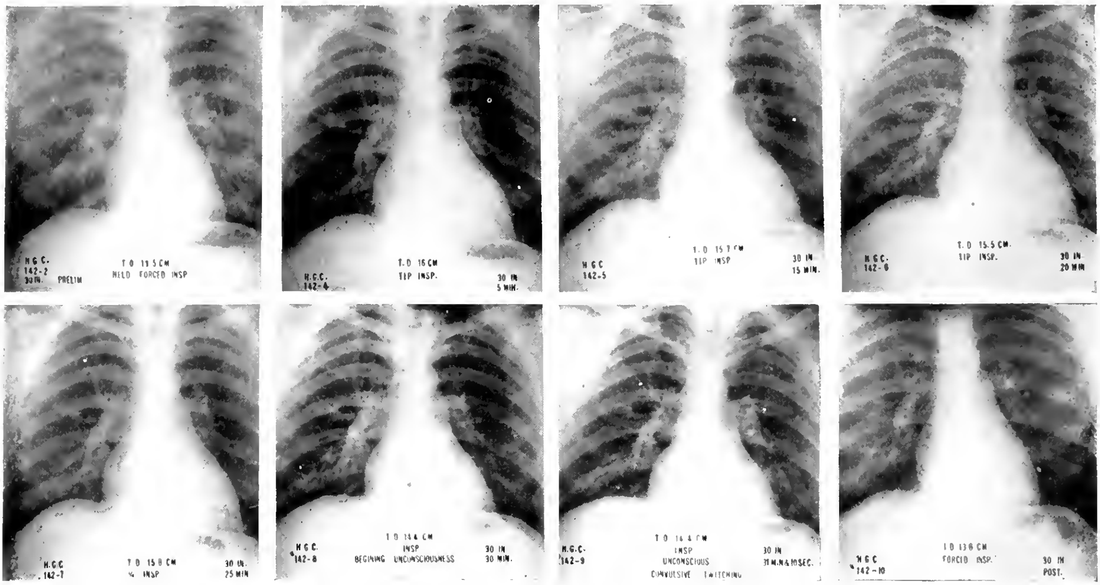


Fig. 21. Case 142. Unconsciousness with Decrease in T. D. and Diaphragm in Expiratory Position at 30 Min.

from 14.1 cm. in inspiration to 13.8 cm. in expiration seems fairly attributable to vasomotor collapse similar to that of the preceding case. The thirty-six and a half minute exposure was made after the blood pressure readings were taken. Had it been possible to take another reading before the subject was removed from the rebreathing apparatus, we believe that a further fall of the systolic and diastolic blood pressures would have been found.

In Case 144 the transverse diameters decreased from a range of 12 to 12.5 cm. during the first thirty minutes of the run, to 11.3 cm. at the thirty-second minute. At this point the test was terminated, the subject being completely inefficient and barely conscious. The final oxygen percentage was 6.5 per cent. During the last two minutes of the run, the systolic blood pressure fell 20 mm. The pulse pressure was then 34 mm. Hg. Two minutes later, the pulse pressure was 25 mm. Hg. The decrease in the transverse diameter in this case also seems to have been due to the lowered blood pressure not completely distending the heart during diastole.

Case 142 is shown in Figs. 8, 9 and 21. The transverse diameter during the first twenty-five minutes of the test varied from 15.5 to 16 cm. It was 14.4 at thirty minutes, and the same at thirty-one minutes and ten seconds when the test was terminated. At this point the subject was breathing 7 per cent of oxygen. He was pale, unconscious, with rigid muscles and fixed jaws. There were slight irregular jerking movements of the head. The pulse was barely perceptible, and the respiratory movements were absent. The cessation of breathing was noted clinically, and is also shown on the kymograph tracing. The subject presented the picture of oxygen want so frequently observed in approaching dissolution accompanied by circulatory failure. When he was removed from the machine and allowed to breathe pure air (after slapping his chest), his recovery was fairly rapid, but not immediate, as is usually the case after the runs on the rebreather. The chart shows that the systolic blood pressure fell 15 mm. during the thirtieth minute, and the diastolic fell 20 mm. during the twenty-ninth and thirtieth minutes, just before the first exposure showing contraction. It may be noted in passing that the diastolic blood pressure is always the first to break. At thirty-one minutes, when the last plate of the run was taken both blood pressures were

still falling. The last plate was taken during the period of apnea, and was obtained during mid-phase respiration or even expiration, as is shown by the kymograph record. The preceding plate with the same transverse diameter was obtained in inspiration. It seems reasonable to think that the measurement would have been smaller had this last exposure been obtained in *full inspiration* like the others.

Case 83, the fifth of this group, was of the vaso-motor fainting type. He fainted during the preliminary examination, before he even saw the rebreather; a faint caused the termination of the run, and he had to have his head between his knees after the control plate following the run. The transverse diameter at the time of his second faint was 1 cm. smaller than at any time during the run, and ½ cm. smaller than that in the preliminary plate taken in forced held inspiration. The roentgenogram made during the faint was also in the expiratory phase, and the systolic blood pressure was 32 mm. Hg.

The foregoing five cases are typical examples of the way in which the circulation usually fails from oxygen want. It is primarily a vasomotor failure, and only secondarily cardiac. The end result, of course in either case, is a faint. But the emphasis in our methods of selection of aviators, so as to eliminate such accidents as fainting in the air, will be entirely different, according as we regard the faint as primarily cardiac in character and arising from "heart strain," or as we regard it as fundamentally vasomotor or neuro-circulatory in origin.

The three remaining cases in which there was a decrease in the transverse diameter form the third group, and one which is not easily explained. There was no evidence of circulatory failure during the run, and varying phases of respiration are not discernible in the plates or in the respiratory tracings.

In Case 28 (Table 2) five plates taken during the first twenty-seven minutes of the run gave each a transverse diameter of 14.75 cm. The next plate made at thirty minutes, shows a transverse diameter of 14 cm. The subject was then unconscious, sitting rigidly in his chair, slightly cyanotic, but the circulation well maintained. The systolic and diastolic pressures were unchanged. Pulse rate had increased from 66 at the start to 105; it was of good quality. The respiratory volume was high throughout. Toward the end, it fell from 173 decilitres per minute during the twenty-eighth minute to only 20 and 30 decilitres per minute for the two minutes following. The small diameter picture was obtained after these two minutes of remarkably small minute-volume respiration. The radiographs show the diaphragm to be slightly higher in the 14 cm. plate than in those with the larger transverse diameter.

TABLE 2.

Case 28. Heart measurements during rebreathing test. Target distance 75 cm.

Exposure	T. D. (cm.)	Area (sq. cm.)
5 min.	(Plate broken)	
15 "	13.50	170
20 "	13.11	158
25 "	13.20	156
30 "	13.40	157
34 " (end)	12.00	132
Post.	(Double exposures)	

In Case 100 (Table 3) the diaphragm is also slightly higher in the final plate of the run than in the preceding ones. The kymograph tracing likewise shows all exposures to have been made in full *inspiration* except the one with the small transverse diameter, which is shown to have been exposed a little below the apex of the curve. The decrease in the diameter is 1.4 cm.

TABLE 3.

Case 100. Heart measurements during rebreathing test. Target distance 75 cm.

Exposure	T. D. (cm.)	Area (sq. cm.)
5 min.	14.75	136
13 "	14.75	140
15 "	14.75	145
20 "	14.75	149
25 "	14.75	151
End	14.00	134
Post. (insp.)	14.50	147

Case 30, which shows a decrease from an average of 16.5 cm. during the run to 15.6 cm. at the end, must also be included in this group of unexplained cases of apparently real decrease in the size of the heart.

These three cases are all excellent ex-

amples of a large class of healthy subjects, who become what the psychologists somewhat technically term "inefficient" under the conditions of low oxygen pressure. Such men frequently show little or no effect of their oxygen want in their circulatory mechanism. Apparently their psychomotor nerve centers are more sensitive to oxygen reduction than are their circulatory centres. It seems possible that in certain persons oxygen reduction acts like moderate exercise to reduce the size of the heart. It is also possible that moderate oxygen reduction in the circulating blood acts in all cases like moderate exercise to cause decrease in the size of the heart. Under such circumstances the decrease would usually occur during the early part of the run, but exceptionally it might not appear until later, as in Cases 28, 30 and 100. It would be small in amount and in most cases overshadowed by the changes due to the varying position of the diaphragm. The fact that in our series, the transverse diameter during forced inspiration after the rebreathing run is almost always smaller than it is before the run, gives support to this assumption of normal cardiac contraction during the rebreathing test. More accurate determination and control of the respiratory phase at which the radiographic exposure is made, may in the future enable us definitely to decide this point.

Just what relation, if any, the enormous increase in the respiratory minute-volume bears to the reduced diameter of Case 28 and to the increased transverse diameter of Case 110 is difficult to determine. In Case 28 we might suspect that the greatly increased minute-volume of respiration so freed the blood from carbon-dioxide that its effect in diminishing the tonus of the heart muscle was lost, and the oxygen, even though reduced, had an exaggerated stimulating effect upon the muscle tonus. The sudden fall in the minute-volume of the respiration during the final two minutes of the run would seem to point to a diminution of the carbon dioxide content of the blood below the threshold at which this respiratory center is simulated by CO_2, and to indicate that oxygen want alone was not a sufficient stimulation. On the other hand, we might suppose that in Case 110, showing enlargement, the carbon dioxide was not pumped out of the blood fast enough to reduce the blood content below the threshold of respiratory stimulation, and that it was still present in sufficient quantity to more than counteract the stimulus to muscle tonus of the reduced oxygen supply. This, however, is only speculation. Unless these discrepancies can be traced to some defect in our method, we must for the present leave them unexplained, awaiting a fuller knowledge of the physiological effects of oxygen reduction in the blood.

In order to help determine whether the changes in the transverse diameters which we have described represent a true contraction or enlargement of the heart, the areas of the heart shadows were obtained with a planimeter. To do this, we outlined the heart on the glass side of the plate and followed the outlines thus obtained with the needle of the planimeter with the aid of light transmitted through a window in a table top. The method of outlining advocated by Shattuck [1] and by Bardeen [2] was used. That is, the right and left borders of the heart were drawn as far as they were clear and distinct, and then these two lines were joined by a smooth curve continuous with them at either end (Figs. 11 and 12). This method unquestionably cuts off a portion of the left auricle and includes a portion of the great vessels at the base. However, we have found it to give more uniform results when repeated on the same pictures at subsequent sittings than are obtained by trying to draw the true outline of the auricle and the anatomically indefinite junction of the great vessels with the heart. By administering to the subject tartaric acid and soda bicarbonate separately in half seidlitz powder doses, the resulting gas in the stomach aids in giving a fairly complete outline of the lower border. Practice with the well outlined shadows enables one to draw those

[1] Shattuck, *Bost. Med. & Surg. Jour.*, March, 1916.
[2] Bardeen, *Am. Jour. Anat.*, March, 1918.

in which the outline is masked by other shadows with a fair degree of uniformity and accuracy.

Our studies along these lines have caused us to draw the lower border with a slightly more rounded outline than does Bardeen. He draws it rather flattened, with sharp curves at its junction with the right and left borders. Our reasons for drawing a more rounded outline (Fig. 11) are some rather extensive outlines we have obtained in the living subject by means of the gas bubble in the stomach, and the fact that by so doing we have obtained more uniform results in the different plates from the same subject. While in a few of our cases with extensively shown heart outlines, the lower border has been flattened, we believe that it is more often rounded, especially during inspiration, the time at which most roentgenograms are obtained. The shape of the heart as well as its position in the cadaver is that of relaxation, and is not that of the functioning organ. We also believe that the rather thin and sharp lower border of the heart is transparent to the roentgen rays and that frequently the shadow which in the silhouette is thought to be the lower border, is really the lowermost portion of the blood-filled ventricular cavity (Fig. 16). Occasionally in forced inspiration we have obtained exposures showing an apparently complete separation between the heart and the diaphragm. We believe that this seeming space is really occupied by the comparatively transparent thin muscular tissue of the lower border.

Comparing the areas obtained in this way with the transverse diameters during the rebreathing run, we found that in Case 30, where there was apparent contraction at the end of the run, the areas did not show any decrease in size.

Case 28 (Table 2) shows a difference of 17 sq.cm. between the largest and smallest area of the silhouette, but the five minute shadow and that at the end of the run show only 2 sq.cm. difference.

Case 100 gives the measurements shown in Table 3. There is a difference of 38 sq.cm. between the largest and the smallest areas; and of 28 sq.cm. between the smallest area and the average area for the rest of the run. This is the greatest variation of the area in our series, and seems to us to indicate the possibility that a real contraction of the heart has occurred in this case. On the other hand, in Case 28 the areas at the beginning and at the end are so nearly the same that we cannot postulate any real change in the size of the heart.

The areas in the five cases showing symptoms of circulatory failure are shown in Table 1, together with the transverse diameters. On the whole, the decrease in the areas corresponding to the decreased transverse diameters is very consistent, and tends to support the theory of an actual diminution of the size of the heart in these cases.

Our cases are as yet so few in number that we have not attempted to decide what are the limits of error in the estimation of the size of the heart from the area of its radiographic silhouette. Case 28 shows a variation of over 10 per cent. Where a series of exposures are made of the same subject and an average area obtained, such an error might be admissible; but when it is desired to obtain an accurate knowledge of the size of the heart from one or two plates, 10 per cent of possible error is too great. We recognize that the error in the estimation of the silhouette area arises partly from varying phases of respiration and the varying degrees of masking of the lower border by the diaphragm; but after all, the difficulty of outlining the upper and lower borders is inherent in the method, whatever the respiratory phase. This difficulty is especially noticeable in the broad flat hearts of stocky individuals having a tendency to overweight.

While theoretically the area of the radiographic silhouette should give a more correct indication of the size of the heart than the transverse diameter, we believe that practically the transverse diameter is a very useful measurement. This is especially true if care be taken to adopt a standard phase of respiration in which to make the exposure. As our studies indicate, the changes in the trans-

verse diameter are less marked in ordinary breathing than in forced breathing. On the other hand, the heart is seen in better outline during inspiration. Therefore, the exposure made in moderate inspiration, as is customary among roentgenologists, is the rational one, whether we are looking for the silhouette area or the transverse diameter. However, certain precautions are necessary as to the time of the exposure. The subject may be able to hold his breath for a considerable period, but his diaphragm will very soon begin to creep either upward or downward. We have taken roentgenograms of subjects holding their breath (Fig. 16) while the nostrils were closed with a spring clamp, such as that used with the rebreather or in the older form of gas mask. Notwithstanding the apparent impossibility for air to escape from the lungs, the diaphragm gradually changed its position. Even when holding the breath for a brief period, unless the subject is thoroughly trained, involuntary efforts to breath will produce changes in the relative positions of the chest wall and diaphragm, which move backward and forward, and upward and downward in reciprocal action and reaction. Care should therefore be taken to make the exposure the moment the respiration reaches the desired phase, or at the beginning of the held breath. Cases 135 and 137, illustrated in Fig. 13, illustrate the changes in the position of the diaphragm when the nose is clamped and the breath held for as long as possible. Incidentally, we may note that the changes in the heart silhouette under such conditions apparently are not all due to diaphragmatic change of position.

In determining the phase of respiration, a simple respirometer is very helpful, exposure being made when the counterweight reaches the proper elevation. We hope to make further observations on the size of the heart in aviators from silhouettes taken when the exposure is automatically set off at a standard phase of respiration. The position for the drum at the time of the exposure can readily be determined from a knowledge of the volume of tidal air when the subject is breathing quietly. This point being decided, all we have to do is to cause a counter-weight to close an electric circuit, which in turn actuates the *x*-ray switch.

As will be seen from Table 4, which shows the summary of the true measurement of the heart as calculated from the 75 cm. silhouette, the hearts of aviators are slightly larger than the standard measurements usually given for young subjects. We believe, however, that these measurements are unusually accurate in that they represent averages of from three to nine silhouettes for each heart. It is possible that they represent an enlargement due to flying at high altitudes, as is claimed for French aviators by Etienne and Lamy. We are inclined to think, however, that our measurements represent rather the heart of the soldier in general, or perhaps the undamaged heart of the athlete, from which class a large proportion of our aviators is drawn.

TABLE 4

TRANSVERSE DIAMETERS AND AREAS OF HEART CONTOURS CORRECTED FOR PARALLEL RAYS

TRUE MEASUREMENTS OF THE HEART IN RELATION TO WEIGHT GROUPS

Weight Group Lbs.	Average Weight Lbs.	No. of Individuals in Group	Controls				Rebreathing Test					
			T. D. (cm.)		Area (sq. cm.)		T. D. (cm.)			Area (sq. cm.)		
			Insp.	Exp.	Insp.	Exp.	Max.	Min.	Average	Max.	Min.	Average
120-129	125.	6	11.9	12.4	107.5	103.7	13.8	11.8	12.2	121	93	104.5
130-139	134.8	12	12.2	12.8	118.1	117.7	13.9	10.3	12.3	136	104	116.5
140-149	143.	24	11.8	13.3	111.1	116.3	15.3	9.6	12.4	141	82	112.8
150-159	152.6	24	12.3	13.7	120.4	120.2	15.0	11.7	12.8	145	86	119.0
160-169	162.8	9	12.9	14.1	119.7	126.9	14.4	13.4	13.6	145	107	122.8
170-179	171.	9	13.1	14.6	116.8	121.5	15.6	12.5	13.5	138	106	122.3
186	.....	1	14.4	15.1	134.	135.	14.2	13.5	13.9	133	124	128.

TABLE 5

Variation of the transverse diameter and of the area of the heart contour during Expiration and Inspiration and during the Rebreathing Test. Measurements at 2 metres and at 75 centimeters corrected for parallel rays.

Case No.	Weight (lbs.)	Height (ins.)	Controls				Rebreathing Test						
			Transverse Diam. (cm.)		Area (sq. cm.)		Transverse Diameter (cm.)				Area (sq. cm.)		
			Insp.	Exp.	Insp.	Exp.	Total No. of Exposures	Max.	Min.	Average	Max.	Min.	Average
5	160	71.	12.6	.....	116.	.....	7	13.9	13.5	13.6	132.1	123.2	128.1
21	153	69.5	13.9	.....	119.2	.....	5	13.6	12.2	12.7	122.4	106.4	115.2
22	158	70.5	14.4	.....	138.0	.....	5	13.2	13.	13.1	128.8	119.5	125.6
23	150	69.5	12.1	..	134.4		5	12.6	12.2	12.4	129.7	119.3	12.2
26	151	71.	12.6	12.6	122.1	117.8	6	12.5	11.7	12.1	110.6	101.7	105.9
28	142	70.	13.0	.....	118.0		5	13.2	12.6	13.1	121.1	107.4	117.0
30	150	67.	13.6	..	117.8		4	15.	13.5	14.4	124.0	117.4	119.3
32	144	68.75	10.6	12.3	86.4	84.	..	12.1	11.0	11.3	92.8	81.8	87.3
34	140	70.	11.5		102.3		7	12.6	11.2	12.2	126.4	98.9	113.9
37	150	67.	10.4	13.0	80.0	82.3	5	12.7	11.8	12.9	104.	85.8	108.1
38	120	65.	11.2	.	91.7		9	12.4	11.2	11.6	108.6	92.9	94.6
39	165	69.	14.0	14.4	117.0	110.0	4	14.13	13.86	13.95	118.	111.0	115.0
40	145	69.5	11.6		94.0	104.0	5	12.6	12.1	12.3	107.2	101.6	104.0
41	143	71.5	10.4	11.7	95.8	95.8	7	10.8	9.6	10.2	97.0	81.8	94.6
44	170	70.	13.2	...	128.8	...	5	13.	12.6	12.7	126.7	122.6	124.1
45	148	68.5	12.1	.....	109.6	..	5	13.2	11.9	12.8	123.8	107.	114.7
47	145	68.5	12.5	....	111.	..	6	15.3	13.9	14.5	125.6	109.6	116.
48	172	69.5	13.7	....	110.4	..	5	15.6	13.7	13.3	119.2	109.6	114.7
51	123	67.5	12.1	....	116.8	....	5	12.6	12.1	12.4	120.	109.6	114.4
52	170	69.	13.9	...		..	6	15.3	14.5	14.8	..		...
53	165	70.5	12.1	..	119.2		5	13.8	12.1	13.6	140.	128.8	132.8
55	124	67.	11.40	11.97	105.	91.	5	12.6	11.9	12.2	102.	94.	99.
58	125	67.	11.	11.52	98.	91.	5	11.8	12.3	12.2	103.2	96.8	100.
61	165	71.	13.5	..	109.	125.	4	14.4	13.9	14.2	112.8	109.2	110.
62	140	71.	12.6	14.4	123.	135.	5	14.	13.6	13.7	140.	129.6	132.8
71	134	69.	Double	Exposure	Double	Exposure	5	12.	10.8	11.7	136.	104.8	123.7
73	170	61.	13.	14.4	116.	117.	3	13.5	12.6	13.3	125.	106.	116.6
74	129	67.	12.6	13.	124.8	113.	6	12.7	12.2	12.5	115.6	103.	110.
76	138	66.5	12.5	13.8	118.	123.	5	13.7	13.5	13.6	121.	116.8	118.
77	140	66.	12.5	13.0	118.	123.	7	13.5	12.7	13.5	121.6	116.8	118.
82	165	72.	12.9	13.9	121.2	117.	4	13.5	12.1	12.9	128.2	107.9	117.9
83	137	68.	11.3	12.2	115.2	116.8	6	12.	10.8	11.6	124.	106.	116.9
84	130	70.	12.6	13.2	123.6	127.9	7	12.9	12.4	12.7	120.6	110.6	114.7
85	140	70.	13.1	13.9	123.	117.	5	13.4	12.5	13.	128.8	107.2	125.9
87	136	71.	14.4	15.1	133.7	135.4	5	14.2	13.5	13.9	132.9	123.6	128.4
88	132	69.5	13.	14.1	133.6	120.2	5	14.3	13.4	14.	143.7	125.	134.1
89	132	68.	13.9	11.7	132.4	114.2	6	12.5	11.5	12.1	122.4	108.8	116.6
90	140	61.	11.9	12.6	109.8	110.4	6	11.9	11.3	11.8	113.3	107.9	110.6
91	140	66.	13.1	13.6	119.4	118.8	6	13.6	12.9	13.3	117.6	112.9	115.
92	138	64.	10.3	12.1	93.	107.5	6	12.1	10.3	11.5	112.8	100.8	107.
93	127	66.	13.2	13.3	114.5	116.	5	13.8	12.7	13.1	120.9	109.7	114.5
94	135	68.	12.2	12.2	108.8	109.6	5	12.8	12.4	12.5	112.7	108.	110.6
96	148	70.5	10.4	11.9	.....		6	12.2	10.8	11.4	104.8	95.4	99.7
97	150	70.	12.6	13.9	126.4	124.8	6	13.6	13.	13.4	132.9	117.	121.3
98	172	70.	Double	Exposure	Double	Exposure	4	12.6	12.5	12.58	122.8	112.	116.8
99	165	72.	12.2	13.	126.5	130.8	5	14.1	13.2	13.8	144.9	128.2	140.2
100	134	69.75	12.7	13.1	136.	123.2	6	12.1	11.8	12.	136.	124.8	128.
102	141	69.5	9.5	12.3	88.8	.	6	11.2	10.3	10.6	108.3	95.3	98.4
103	158	73.	10.7	.	106.4	.	2	12.4	12.	12.2	117.8	112.8	114.8
104	154	69.	11.8	14.4	142.4	116.8	3	13.1	12.4	12.7	125.6	112.8	119.6
105	170	70.	12.4	..	112.	...	4	13.9	13.5	13.7	128.7	116.7	123.8
106	153	69.	Double	Exposure	Double	Exposure	5	13.7	13.1	13.3	126.5	116.	122.3
107	128	66.5	12.	....	105.6	...	2	12.	11.3	11.7	102.	100.	101.
108	135	71.	Double	Exposure	Double	Exposure	3	12.1	11.7	11.9	112.	98.8	105.7
109	152	71.5	12.3	14.3	Double	Exposure	5	12.3	12.1	12.1	128.9	119.5	124.2
110	141	71.3	11.3	13.5	Double	Exposure	5	12.3	11.7	12.1	120.4	110.	114.5
112	140	70.	10.3	13.	Double	Exposure	5	12.6	12.1	12.3	132.4	121.9	126.5
114	152	71.5	Double	Exposure	Double	Exposure	5	12.8	12.4	12.6	113.	107.8	109.2
115	150	68.	13.1	14.5	121.5	129.6	5	13.7	13.3	13.5	136.	125.1	130.5
116	160	68.	12.4	12.6	101.6	126.	5	14.4	13.9	14.	140.1	124.	128.7
118	175	73.	Double	Exposure	Double	Exposure	3	14.4	13.5	13.6	138.2	136.7	137.4
119	135	69.	.....	14.7	Double	Exposure	5	13.9	13.3	13.5	127.	119.	122.
120	170	69.	13.	14.8	Double	Exposure	4	15.4	13.9	14.3	129.6	120.	124.
121	155	68.5	12.8	14.5	Double	Exposure	3	14.4	13.5	13.8	129.6	119.	123.
122	140	67.	13.5	14.4	Double	Exposure	7	13.9	12.4	13.2	113.9	95.6	109.1
123	154	71.75	12.2	13.0	117.2	106.4	4	12.8	12.2	12.5	115.2	104.8	110.4
125	145	68.5	11.8	13.5	112.	111.7	5	12.9	12.7	12.8	110.7	101.5	102.5
126	160	69.	13.5	14.4	119.	111.	5	14.0	13.6	13.9	117.6	107.2	113.9
131	155	67.	12.9	13.	.	....	5	13.	12.8	12.9	109.	104.	107.7
132	152	71.	12.1	13.8	120.	119.	5	12.8	12.3	12.5	132.	115.	123.6
133	162	67.	13.3	15.2	131.2	136.	6	13.7	13.5	13.6	144.	122.	127.
134	145	68.	11.4	14.4	103.	125.3	7	13.7	12.4	13.1	109.5	102.	106.
135	146	71.	12.	13.	125.	115.	5	12.2	11.5	11.8	119.	107.	114.6
136	150	66.	12.6	14.1	109.6	109.	5	13.5	13.1	13.3	116.	110.4	113.
137	145	70.	11.9	13.9	125.6	108.0	6	12.6	11.9	12.3	121.6	105.6	114.4
138	159	69.	11.7	14.5	119.2	138.4	5	13.9	13.7	13.8	144.0	130.4	136.
139	170	72.	12.7	14.6	116.8	125.6	5	14.0	13.5	13.8	124.8	115.	121.
140	...	....	11.7	12.9	98.4	105.6	3	12.1	12.1	12.1	112.	108.	110.
141	150	70.5	11.5	13.5	119.	129.	2	12.1	11.7	11.9	112.	108.	110.
142	143	68.	12.2	14.4	117.	124.8	6	14.4	13.	13.8	129.9	114.2	123.5

TABLE 5—*Continued*

Case No.	Weight (lbs.)	Height (ins.)	Controls				Rebreathing Test						
			Transverse Diam. (cm.)		Area (sq. cm.)		Transverse Diameter (cm.)				Area (sq. cm.)		
			Insp.	Exp.	Insp.	Exp.	Total No. of Exposures	Max.	Min.	Average	Max.	Min.	Average
143	145	71.	12.1	13.1	.....	121.6	5	13.5	11.8	12.6	133.6	108.	117.6
144	146	71.	10.3	13.1	104.	120.8	6	11.2	10.1	10.8	115.	92.8	109.
146	145	68.5	12.5	15.2	131.2	144.	4	14.4	14.2	14.1	145.6	136.8	140.8
147	161	70.	12.9	14.9	124.8	140.	5	13.4	12.6	13.1	121.	109.6	113.
149	164	68.	14.	14.2	.....	120.9	6	14.0	13.	13.5	124.	115.	120.
151	150	68.	12.3	14.1	108.	119.	5	13.5	12.7	13.1	119.	100.	108.
152	155	71.	12.6	14.8	130.	152.	3	14.2	13.	13.3	140.8	130.	135.6
153	155	70.5	12.	12.9	124.	123.	5	13.1	11.7	12.7	122.	116.	119.
154	152	71.	11.7	13.	110.	107.	5	12.6	12.2	12.4	123.	106.	114.8
156	160	69.	12.1	15.	131.	143.	4	13.7	13.5	13.6	142.	129.	138.8

[NOTE.—In Tables 4 and 5, the measurements given are the true diameters and the true areas of the contour of the heart as calculated mathematically. For this purpose the plane of the contour of the heart which gives the silhouette is assumed to be parallel to the plate, and its distance from the plate 8 cm. It is admitted that the plane of the contour may not be absolutely parallel to the plate in many or even in all cases. The silhouettes will evidently be distorted in proportion to the departure of the plane of the contour from parallelism with that of the plate. An effort was made in our work to reduce this distortion to a minimum by having the back of the chair tilted slightly forward so as to bring the gladiolus of the sternum parallel to the plate as recommended by Bardeen. The distance of 8 cm. from the plate for the contour is larger than usual because we were compelled to allow for the movements of the chest during the deep breathing which our subjects indulged in during the progress of the test. The sternum was not always in contact with the plate. As our work was undertaken primarily to compare the heart measurements obtained during the course of the rebreathing test in the same subject, and not those of one subject with another, we believe that the possible distortion resulting from these departures from the standard method is negligible.

In order that our measurements may be compared with those of other observers, we have endeavored to convert them as accurately as possible into the true measurements of the heart contour. We have done this on the formulae that the true diameter and the silhouette diameter are directly proportional to their distance from the target; and that the two areas are directly proportional to the squares of their distances from the target. Assuming the heart contour to be 8 cm. from the plate, these formulae give the following relations:

With heart 8 cm. from the plate

Target 2 meter distance
True T. D.=96 per cent t. d. of silhouette
True area=92 per cent area of silhouette
Target 75 cm. distance.
True T. D.=89.6 per cent t. d. of silhouette
True area=79.6 per cent area of silhouette

DISCUSSION OF ARTICLES ON THE HEART BY DRS. VAN ZWALUWENBURG, HOLMES AND LE WALD

DR. A. W. CRANE.—Dr. LeWald's work is certainly one of great interest and has involved the construction of new and strange apparatus. It will be remembered that Dr. LeWald's plates showed an enlargement chiefly to the left, occasionally a little to the right. I think that the doctor did not insist in any case that this was a true dilatation of the heart. It would seem rather to be an "effort-syndrome" of the heart without muscular or valvular decompensation. The most interesting point to me was that the signs produced by this effort disappeared with the administration of oxygen. The effort of the heart is put forth by reason of the diminished oxygen in the blood rather than because of the diminished

atmospheric pressure or increased work. This is true research, and more of that work is needed.

The paper of Dr. Van Zwaluwenburg would be a joy to discuss, but our time prevents full discussion of it. There is no reason why there should be any antagonism between the fluoroscopic estimation of the heart's outline and the estimation by the Bardeen method of a plate at six feet distance. The fluoroscopic method means making dots along the outline and introduces the variant of the personal equation. It also necessitates special apparatus. If you want to do it there is no reason why you should not, but it is a saving of time to take the plate at 6 feet and make the necessary reduction. This requires only apparatus that you have in your office.

The estimation of heart-volume by diameters in comparison with estimating the heart-volume by taking the square area, seems to me to admit of no argument whatever. There is no set of diameters that you can rely upon. But you may obtain the square area easily by that little instrument in use by engineers, the planimeter. There is no mathematical formula for estimating an irregular outline such as the heart silhouette. It seems an error to try any mathematical calculation for estimating this silhouette.

Not only can you estimate the heart-volume by the Bardeen method, but you can also estimate the approximate weight of the heart muscle and the weight of the heart-blood. This does not mean that you will not use the fluoroscope and observe the beating chambers and make other observations, but it does mean that when it comes to the estimation of the size of the heart, we should use the Bardeen method.

Dr. Bardeen has put into our hands a set of tables which represent the fruits of his work. So far as I know, there are no other tables accessible which compare in accuracy whereby we can recognize heart-volume in relation to body-size, weight and age. We can take pride in the work of Dr. Bardeen as that of an American.

I must pay my compliments to Dr. Holmes, and I believe that this work which he is doing will put the study of the pericardium on a sounder basis for clinicians as well as for roentgenologists.

Dr. George E. Pfahler.—I have been very much interested in the study of the heart. The question of outlining the heart by the orthodiagraph, as far as estimating the size of the heart, has never appealed to me strongly. You cannot ignore it, but it is only the gross changes that become important. It is very difficult to estimate how large the size of the heart of any man here should be; if we can't tell that, it is extremely difficult for us to tell our patient how large his or her heart should be. There is no man here who could tell me how large my little finger should be, because my occupation and my ancestry and other things come into play just as they come into play in estimating the size of my heart. I do not believe we should attach too much importance to the size of the heart. I believe we should attach more importance to the strength of the heart and the force of the contraction, and there is where I think fluoroscopic examinations come into use. With experience you can judge the strength of the heart's contractions and the strength of the heart muscle, and that after all is more important than its size.

Dr. L. T. LeWald.—I am much interested in Dr. Holmes's work. I did a series of investigations on the cadaver and used lead acetate ti simulate the density of the effusions as Dr. Holmes did with salt solution, and our results were comparable to his work. We were unable to detect the heart shadow inside of the fluid shadow. I think Dr. Holmes's work is going to clinch some of the points that are in dispute and leave us in a position where we can determine the presence of large collections of fluid.

Dr. George E. Pfahler.—I appreciated Dr. Holmes's work very much, but I would like to ask Dr. Holmes whether he considers obliteration of that curve on the left side of the heart as characteristic. He said he observed it in these cases, which we are willing to accept, but to make it of importance we must find whether it is possible to say that it is characteristic or at least always present.

Dr. W. H. Stewart.—It was my privilege to examine a large number of cases of influenza and pneumonia at Debarkation Hospital No. 5, during the epidemic of last winter, a great many of which had pericardial as well

as pleural effusions. I might say that it was very difficult to determine, from the roentgenographic findings, whether or not pericardial effusion was present. Those that went to post-mortem we studied very carefully with Doctor Lambert, and noted, where pericardial effusion was present, that most changes in the cardiac outline occurred at the base rather than at the apex. Of all the cases we saw that went to post-mortem, I do not remember more than one in which the cardio-diaphragmatic angle was obliterated. They all had a very sharp outline, and all effusions in this class of cases seemed to travel up and to increase the width at the base.

Dr. F. S. Bissell.—In our work at the University of Minnesota we have found it advantageous to emphasize the cardiac type rather than the cardiac volume, and in doing that if one is to construct tables which are of value, one must correlate the cardiac type with the individual type, as Dr. Pfahler suggested. It is absolutely necessary to determine before the case is examined under what classification the individual comes and then determine the cardiac type.

Thus in an asthenic individual the aortic type of heart outline is much more significant of actual valvular disease than in the short and broad-chested individual. If the heart is not true to type we are at once suspicious of some pathologic change. Roentgen reports should therefore describe the individual type, the normal heart for such an individual and the type of heart under consideration, the latter being based upon both size and configuration. We find a considerable number of asthenic or drop hearts which are dilated and such cases are best diagnosed by means of the fluoroscope. The characteristic pulsation phenomena of the drop heart shown by an apparent shortening of the long axis and rotation during systole is more significant than mere size. In short it seems to me that there are many considerations in roentgen cardiac diagnosis which are of greater importance than the study of dimensions and cardiac volume.

Dr. A. W. Crane.—I would be sorry to have this discussion close without another opportunity to add something more in regard to the size of the heart. Now the importance of the size of the heart does not have to be settled by roentgenologists; it has been settled by internists in clinical medicine. There is no datum which is more fundamental in cardiac pathology than the size of the heart, and clinicians have long attempted to estimate the size of the diseased heart. Normally the size of the heart is delicately adjusted to the size of the individual. It even varies in size whether sitting, standing or lying. The difference is remarkable, being from 5 to 12 per cent between the upright and horizontal positions. The heart is an elastic body and varies within normal limits at different times in relation to digestion, exercise, etc. It is not to be compared to the size of your nose, which may be large or small as a matter of inheritance. An enlarged heart is never a normal heart. I would maintain that the estimation of the size of the heart in relation to the size and weight of the individual is one of the most important of the cardiac data which we are able to furnish the internist.

Dr. L. T. LeWald.—I think the suggestion in regard to the composite of the heart shadow in a given individual is about as near a correct method to use as we can find, and it is a common method of arriving at conclusions with engineers, that is to make a number of observations and then take a mean. I think it would be correct for us always to do that in arriving at the estimation of the heart's size, and not be content with a single exposure at six feet, but take a group of exposures and average those measurements as worked out by the planimeter.

Dr. James G. Van Zwaluwenburg.—It seems to me that in spite of the apparent disagreement in the discussions, we are not so far apart in the question of measuring the cardiac area, and our position is mainly this: that although the estimation of the cardiac area is important and of value and can be made with more accuracy than the clinician can do it, there is no use in depending on it so religiously and so slavishly as we depend on a scientific instrument of precision. It is a gross measure. Why use an instrument of precision and introduce into a method of approximation an instrument of such refinement as to encourage a feeling of scientific reliability which is not justified? If you want to measure the approximate distance from here to Washington, why make a triangulation? You might just as well take observations of the stars and make an

approximation. The estimation of the cardiac area is only one small item in estimating the condition of the heart.

But we must get all the fluoroscopic evidence, and we cannot recognize the different chambers of the heart by the plate method; I am satisfied of that. I have tried it again and again.

I want to say a word of appreciation of the work of Dr. LeWald. About six years ago I did some work with Dr. Hewlett in an "effort experiment." We tried to determine the behavior of the heart under exercise, and I know something about the difficulties. The fact that the difficulties were so great that we reached no conclusion is the reason the research was never published, and I can appreciate very well the necessary refinements of technique and the difficulties Dr. LeWald has met in reaching satisfactory conclusions.

Dr. W. F. Manges.—In regard to the experimental work in pericardial effusions, can we compare what would happen if we dilated the pericardium suddenly with a pericardium that dilates with the very gradual production of fluid? In other words, is it not true that tissues under tension accommodate themselves in a manner that is different from a sudden dilatation, and can we then take the curves and the shapes that are produced under mechanical dilatation suddenly as an indication of what does occur in pericarditis with effusions where the effusion may be of gradual onset? I recently had occasion to study a patient with a general anasarca. There was an enormous amount of fluid in the abdomen, the heart shadow was enormously enlarged also, and because of the general picture of anasarca I assumed that there was a pericardium filled with effusion. We tapped the abdomen but did not tap the pericardium. The shape of the heart shadow in this instance was much like that of a large heart, perhaps of a heart that had been once hypertrophied and had then become dilated. In other words, it seemed to me there was no comparison between the shape of that heart shadow and one of those artificially produced by pericardial fluid.

Pericarditis with effusion is not always diagnosed, I am quite certain, and that must be clear because at postmortem it is found without there having been any diagnosis made at all. We do not get an opportunity to examine all of the heart cases in our hospital clinics, that is, we do not examine all of them by means of the *x*-ray. It occurs to me that there is still more work to be done along this line; and while the experimental work of Dr. Holmes is very important, I think he needs to carry it out a little further.

Dr. George W. Holmes.—I will first answer Dr. Manges' question and later Dr. Pfahler's. Of course, this experimental work was not done to determine the changes in the shape of the heart. The object of the work was to determine whether or not we could show the heart shadow within the fluid-filled pericardium and incidentally we came upon this obliteration of the cardiac curve. Now the obliteration of the normal curves of the chambers of the heart is not a new observation. Williams calls attention to it in his book and some of the French writers speak of it. I cannot answer positively Dr. Pfahler's question as to whether this obliteration in the normal curves is always present. I should say that in the large majority of cases it is. If careful fluoroscopic observations are made we can usually determine the different chambers in dilated hearts. In pericarditis with effusion or obliterative pericarditis, the outline of the heart chambers is lost.

The final diagnosis in these cases is hard to obtain. It is very difficult to get positive evidence even at autopsy. The pericardium may fill up with fluid after death. A case has been reported in which the *x*-ray examinations and clinical signs suggested fluid and from which pus was obtained by tapping; but at the autopsy the pus was found in the mediastinal cavity and not in the pericardium which contained only serous fluid.

We must have very positive evidence before drawing conclusions from the *x*-ray findings in these cases. I agree with what Dr. Van Zwaluwenburg said. The more of this work you do, the more you come to rely on the fluoroscope. Many good clinicians want to know not the size of the heart but its condition.

The shape of the heart and the strength of its pulsations are of more importance than its size, but its size is of value in checking up percussions; and we must have some method of measurement, but I think we ought not to take it too literally.

REPORT OF SOME INTERESTING THORACIC ANEURYSMS

By A. ROBERT TAFT, M.D.
Professor of Roentgenology, South Carolina Medical College.
CHARLESTON, S. C.

A NEGRO referred from one of the neighboring Sea Islands had a pulsating mass of aneurysm of thoracic eroded through ribs and sternum. This was principally in the second and third right interspace.

Patient was about forty years of age and gave syphilitic history. He was given specific treatment by his physician after our findings with little hope even of improvement and was lost sight of later. These cases are, I am sure, becoming less and less common as better facilities for diagnosis and treatment, even in the remote rural districts, are making the extreme end results of syphilis rarer.

The second case I have to report died in the Roper Hospital, and the courtesy of the staff of the South Carolina Medical College made it possible to follow the history and autopsy findings. A white man of thirty-four was admitted to our outdoor clinic and finally to the hospital in July with a working diagnosis of syphilis and aneurysm of the aorta. The history showed that in 1900 he had gonorrhea and buboes. He had had no specific treatment for any length of time. He used whiskey and tobacco excessively. Had been married nine years. His wife had had several miscarriages and two stillborn children. The wife had lost a large portion of her nose, probably through syphilis.

The patient was quite well until, in November, 1918, while working, he was suddenly taken with pain in his back between the shoulder blades. This was very severe and has continued off and on ever since. It is pulsating and at times affects his breathing. He has a loud, harsh cough and hoarse voice; experiences considerable difficulty in swallowing.

Examination shows dullness and increased vocal fremitus and breath sounds at right apex. There is also some scattered râles and soft systolic murmur. A loud roaring synchronous with heartbeat can be heard under either clavicle, best under the right. Left pulse is slightly stronger than right. Wassermann 4+. He died three weeks after admission.

The roentgen examination showed a mass about the size of a grapefruit filling the upper right thorax. Lateral fluoroscopy showed a large mass blocking the upper mediastinus. This extends back like a large ball and the mediastinum is quite clear below. Unfortunately the lateral plate was destroyed.

The autopsy showed the heart about one and a half times the normal size; competent aortic valves; mitral valves, short hard and rather firmly bound down; tricuspid orifice much dilated; beginning at aortic valve leaflets. Aorta showed fairly uniform thickening. A few yellowish elevated areas are seen on intima of ascending portion. About the middle of the ascending aorta there is globular enlargement. This increased in size as the transverse portion of the arch was approached. The enlargement on inspection appeared completely to surround the aorta which occupied nearly its center. On the posterior wall of the aorta, about midway between the innominate and left common carotid, was a circular opening about seven-eighths of an inch in diameter communicating directly from lumen of aorta to interior of enlargement. The enlargement extended to the left common carotid, where it ended. Its interior was filled with laminated clots, many of which were lying loose, while others were attached.

The walls of this enlargement were composed wholly of the mediastinal tissues, with large quantities of fibrous tissue which had developed in an effort to increase the strength of the enlargement. Enclosed in

its posterior walls were trachea; esophagus and numerous nerves. Posteriorly the whole was firmly attached to the vertebral column from the second to the sixth thoracic vertebra. All of these showed deep corrosion, especially the fourth, in which the body was a mere shell and the finger could be passed backward to the spinal canal. The descending aorta was to all appearance perfectly normal.

The third case was referred for possible aneurysm of the thoracic aorta. The symptoms were chiefly dyspnea and murmur of pulmonary area. The case as seen with the x-ray is one of aneurysm of the pulmonary artery. No blood examination was made. This condition is often associated with persistent ductus botalli.

Fig. 1. Aneurysm of Ascending Aorta.

Fig. 2. Large Dissecting Aneurysm of Thoracic Aorta.

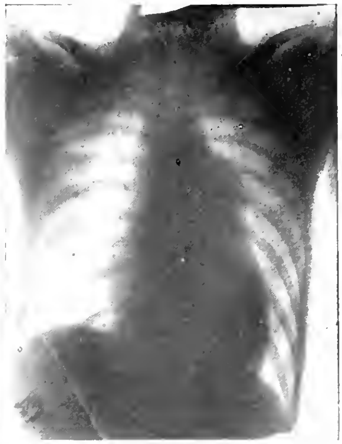


Fig. 3. Aneurysm of Pulmonary.

My excuse for reporting these cases is that they (especially the first and second) present this class of immense aneurysms which from better treatment are becoming rare. We all believe these cases to be syphilitic, and on account of the great number of Negroes they are much more common in the South than in other sections of the country. Out of a good many thousand x-ray examinations in two years' work in the Navy I never saw one thoracic aneurysm. This, I believe, is due to the fact that there were comparatively few Negroes. There were physical examinations at short intervals, precluding the possibility of cases running to such extremes, and very few early syphilitic lesions got by without note on health record and very thorough treatment and follow-up.

TREATMENT OF CANCER, PARTICULARLY OF THE TONGUE, TONSIL AND RECTUM, BY BURIED EMANATION*[1]

By H. H. JANEWAY, M.D.

NEW YORK CITY

DURING the past year and a half the use of buried radium emanation has opened up in our experience at the Memorial Hospital new possibilities in the treatment of cancer by radium. For at least two years from the beginning of our experience with radium we made use of only local application of radium to surfaces of cancer. By this method the new growths were attacked from only one surface, and every device was resorted to for the purpose of obtaining complete and as uniform penetration as possible of the whole thickness of tumors. Heavy filtration was resorted to for the purpose of eliminating all but the very penetrating rays and thus obtaining not only a deep effect but one more uniform. Whenever practicable, the radium was applied at a distance from the growth, for the purpose of subjecting the surface of the growth and its deeper portions to as nearly the same dosage as possible. Every means was made use of for the purpose of evenly distributing the radiations over the surface of tumors, such as embedding the tubes in molds of the tumor made of dental modeling compound and pinning the tubes to the surface of the tumors and ulcers by little hooks, or folding rows of tubes in pleats of cotton cloth.

The results of these methods in many instances were excellent, and have been fully described in the monograph published recently from the Memorial Hospital on "Radium Therapy in Cancer." These methods are still in use in selected cases, but none of them compare with the results more recently obtained by embedding emanation, sealed in minute glass tubes, within the tumor tissue. By thus using emanation, the radiations are not only far more evenly distributed throughout the tumor but a much more intense and better localized radiation of the tumor is obtained than by other methods.

Duane deserves the credit of having first suggested this use of radium emanation. Stevenson[2] has reported 22 cases very successfully treated by this method. They include 3 cancers of the tongue, 4 of the uterus, 2 of the breast, 2 of cervical glands, 1 abdominal tumor, 2 epitheliomas of face, 1 parotid tumor, 1 of nasal cavity, 1 lymphosarcoma, 1 epithelioma of palate, 4 rodent ulcers.

We have used this method continuously during the past year at the Memorial Hospital. The radium emanation is collected in the usual manner in a long capillary tube, which is divided into minute parts by a flame, sealing the ends, as it divides the tube. These tubes measure 3 mm. × ¼ mm.

A machine for mechanically dividing these tubes has recently been constructed by Mr. Turnbull after designs by Mr. Failla. With this machine a large number of these tubes can be prepared in a very short time, and so prepared that they are more uniform in size and length than when they are divided by hand. The tubes are easily placed in the distal end of a needle which is no larger than a slender aspirating needle. The aspirating needle is then inserted within the tumor tissue and the tube is expelled by the wire stylet of the tube. By inserting other tubes in various places in the tumor, a very uniform distribution of emanation only lightly filtered is secured throughout the

[1] Radium emanation is a gas given off from radium at a constant rate. It emits all the therapeutically active radiations of radium. It and its method of collection are fully described in the book on radium therapy in cancer published from the Memorial Hospital in 1917.

[2] Stevenson, W. C. "The Theory and Technique of a New Method of Radium Therapy," with notes on cases treated during the last nine months. *Dublin J. Med. Science,* 1915, CLIX, 177.

*Read at the Third Annual Meeting of the American Radium Society, Atlantic City, N. J., June 5, 1919.

vhole tumor. There are numerous advan-ages in this method:

1. There is very little loss of the radia-ions, inasmuch as the emanation is inserted vithin the tumor tissue and left there either ermanently or until it sloughs out. Almost oo per cent of its efficiency is directed gainst the tumor.

2. It is a most economical way of using adium, as small quantities will produce hanges accomplished by other methods only vith the use of large quantities.

3. Instead of wasting the more weakly enetrating gamma rays and the beta rays y filtration, the tumor tissue itself is made) act as a filter, and those rays, which are ltered out by other methods, particularly he beta radiations—ten times as numerous s the gamma rays, are made use of to estroy the growth.

4. A more intense radiation of the rowth can be secured with greater safety nd with less discomfort to the patient, be-ause these softer gamma radiations and the ar more numerous beta radiations possess a imited range of penetration around each ube as a center, and in consequence heavy osage can be given to the tumor tissue lone with little damage to the surrounding issues.

5. The simplicity of the method makes it ot only the easiest method of exposing tu-nors to radium, but furnishes a way of horoughly radiating tumors which are in-ccessible to any other method of treatment, or instance, tumors of the tonsil, the yriform sinus, or even the rectum.

All these claimed advantages have been nore than substantiated in practice. To illus-rate them, I have selected one or two cases rom each group of carcinomas in which we have found the method especially valuable. They include two cases of cancer of the ongue; 2 cases of cancer of the tonsil; 1 ase of lymphosarcoma of the tonsil; 1 case of branchiogenetic carcinoma of the neck; case of advanced recurrence in the cervical ymph nodes, secondary to a carcinoma of he tongue previously and apparently suc-essfully removed by operation; 1 case of advanced primary carcinoma of the antrum; 1 case of cancer of the rectum; 1 case of cancer of the labium minum and urethral orifice; and 1 case of cancer of the cervix uteri. Again it may be emphasized that these cases are only illustrations of others like them in each group. The method is not—as perhaps is true of all present day methods of dealing with malignant new growths—en-tirely devoid of danger. Two patients with suppurating growths died of sepsis; a num-ber of patients have died of hemorrhage. However, the chance for life which many patients have is far greater when treated by this method than with any other method of using radium, and in a measure the dangers can be successfully guarded against.

Sepsis is most to be feared in feeble pa-tients or subjects with otherwise lowered resistance who possess suppurating tumors. Hemorrhage is a very real danger and is most to be feared in the treatment of cancer of the tongue or tonsil. There is no method of successfully coping with it except by ligation of the external carotid and lingual artery in the case of cancer of the tongue, and of even the external and common ca-rotid in cancer of the tonsil, though the ne-cessity for this radical step is rare. The com-mon carotid may be more safely ligated if the operation is done under local anesthesia in two stages. In the first stage the lumen of the vessel is not completely obliterated by the use of a silver wire which is replaced by another ligature in twenty-four hours' time. Comparatively few patients develop severe hemorrhage, and it is almost always safe to wait for indications that dangerous hem-orrhage will take place, such as preliminary small hemorrhages, before ligating the ves-sels. The almost universal necessity of opening the neck for the removal of the lymph glands obviates in part the objection to ligating the large vessels, for the two procedures can be done at the same time. The liability to hemorrhage does not always bear a definite relation to the dosage em-ployed. The most striking illustration of this was a patient who was being treated for a rather small cancer of the tonsil on January

7 and March 18, 1918. The dose employed on January 7 was only 6 mc., and on March 18, 4.5 mc. Complete healing of the lesion took place, so that the lesion was considered cured early in the summer of 1918; and yet without apparent cause or recurrence of the induration, a small area of gangrene developed in May 1919, and the man died of sudden hemorrhage two weeks later. Such accidents are very unusual. Another danger, to be less feared however, is necrosis. In strengths of tubes practical for embedding in tumor tissue 1-2 mc., there develops around each tube a sphere of necrosis. Bagg has shown that necrosis may extend through a sphere 1 cm. in diameter around a tube containing 1 mc. This necrosis develops slowly and is slowly replaced by fibrous tissue. It is largely due to the beta radiation, and inasmuch as the beta radiation is so much greater than the gamma radiation, the distance of the extent of the necrosis from the tube does not bear a relation to be expected off-hand to the strength of the tube. An excessive necrosis, or one too suddenly produced, may be accomplished with toxic symptoms. It is probably due to this cause that we have had certain bad results in the treatment of pyloric cancer by buried emanation. When embedded in thin-walled hollow viscera the necrosis around buried emanation tubes may cause perforation. Their use in the esophagus and in certain places in the stomach and intestines and near large vessels or nerve trunks unprotected by thick layers of tumor tissue is contraindicated for this reason. This danger has not, however been encountered in the rectum, where the most gratifying results have followed the use of buried emanation. As a rule the most favorable results follow the use of the buried emanation—results such as can be obtained in no other manner. The method has made possible the successful treatment of lesions in the mouth and rectum which previously we would not have attempted to treat.

Fig. 1. Epidermoid Carcinoma of the Tongue, Clinically Cured by Once Embedding Emanation in its Substance.

Fig. 2. Advanced Epidermoid Carcinoma of the Tongue Clinically Cured by the Combustion of Surface Applications and Embedding Emanations.

The most important factor in success by this method is the selection of the proper dose for the first treatment. At present no absolute directions for dosage can be given. Because of cross-firing the dose is proportionately less for large tumors than for small ones. At present it is dangerous to formulate rules. The appropriate dose is solely a matter of judgment developed from experience. The best guide is the dosage used in the following case reports selected to illustrate this method. We are gradually approaching a standard dosage which we hope soon to publish.

Case Histories

Two well established cases of carcinoma of the tongue clinically cured by embedded emanation.

Case 1. E. F., female, thirty-six years, applied for treatment February 4, 1919.

History.—The teeth had been in poor condition for years. Six roots had recently been removed, around which there were pus pockets. In November, 1918, an ulcer developed on the right lateral surface of the tongue which was thought to be a canker sore. Two similar ulcers developed near the tip of the tongue. These last spontaneously healed, but the first ulcer on the lateral surface of the tongue gradually increased in size.

Examination.—On the right lateral surface of the tongue, opposite the site of the molar teeth which have been removed, is an ulcer 2½ cm. in diameter. The base of this ulcer is raised ½ cm. and is covered with neoplastic nodules. There is only a shallow infiltration of the substance of the tongue beneath the base, although the lesion is bulky. (Fig. 1.) No palpable lymph nodes.

Microscopical examination.—Epidermoid carcinoma.

Treatment.—February 4, 1919. 13.1 mcs. in three small glass tubes embedded in the substance of the ulcer.

February 6, 1919. 292 mc. in four tubes of ½ mm. silver placed on the surface of the ulcer in a mold of dental modelling compound for one hour. Following the treatment the patient became more comfortable, suffering no unpleasant reaction whatever.

February 27, 1919. No evidence whatever of any disease.

Case 2. P. T., seventy years, male.

History.—Has been an immoderate smoker, usually with a pipe, for years. Edentulous for the past six years. A small ulcer developed on the right border of the tongue a year and a half ago. This ulcer has gradually increased in size and become painful.

Examination.—On the right border of the tongue, from the middle to near the tip, is an ulcer 4½ by 2½ cm. in diameter. The edges are raised and hard, and nodular. The base is hard and elevated. The infiltration of the substance of the tongue beneath the ulcer is not deep. (Fig. 2.)

Treatment.—March 27, 1918. 305 mc. in 8 tubes of ½ mm. silver, applied to the surface of the ulcer in a mold of dental modeling compound for two hours.

March 28, 1918. 9.85 mc. in three minute glass tubes embedded in the substance of the lesion. Following the treatment the ulcer healed, but an indurated plaque remained at its site.

June 3, 1918. 8.5 mc. in five minute glass tubes embedded in the substance of the residual indurated tissue. Following this treatment all induration disappeared.

June, 1919. No evidence of disease.

Case 3. Advanced carcinoma of the tonsil clinically cured by one treatment by buried emanation.

C. W., fifty-six years, male, No. 25663, applied for treatment July 19, 1918.

History.—Chews tobacco. Two months before applying for treatment noticed some stiffness in the neck and a sensation of a lump in the throat. Admits syphilitic infection, for which he has received salvarsan and mercury for the past two years.

Examination.—The right tonsil and the adjacent portion of the anterior pillar of the fauces is destroyed on its surface and infiltrated deeply by an ulcerated, hard, neoplas-

tic mass. The deep cervical lymphatics along the anterior border of the sternomastoid muscle are enlarged.

Microscopical Diagnosis.—Epidermoid carcinoma.

Treatment.—14.8 mc. in six minute glass tubes, embedded in the substance of the tumor tissue.

August 19, 1918. Much improved; ulcer healing; induration disappearing. The glands on the neck have disappeared.

November 22, 1918. Healing complete. No evidence of disease.

CASE 4. Advanced recurrent lymphosarcoma of the tonsil with huge cervical metastases clinically cured by one treatment of buried emanation.

C. W., seventy years, male, No. 25297.

March 19, 1918. *History.*—Uses both tobacco and alcohol; denies syphilis. About two and a half years before applying for treatment, the left tonsil became enlarged. Finally it interfered with speech and deglutition. In six months, that is, two years ago, it was removed. Three months after this operation he again noticed discomfort in the throat, which increased. Six months ago the lymph nodes in the right side of the neck became enlarged.

Examination.—Both tonsils form spherical smooth masses of approximately 3 x 4 cm. in diameter. They touch each other in the middle line and almost completely block the entrance into the pharynx. The cervical lymph glands on the left side of the neck are enlarged, forming a nodular mass 10 cm. in diameter at the base and filling the space between the body of the lower jaw to one inch above the clavicle. There is only a small node, the size of a pea, present on the right side of the neck. No enlarged lymphatics in the axillae.

Treatment.—March 27, 1918. 12 mc. in four minute glass tubes embedded in the substance of the tonsil. 10.55 mc. in four tubes embedded in the substance of the lymphatic tumor of the neck.

A very rapid retrogression of all tumor tissue followed this treatment.

April 8, 1918. Practically no remnants of the original disease left, either in the throat or neck.

December 20, 1918. He has remained free from disease to date. (June, 1919.)

CASE 5. Advanced branchiogenic carcinoma of the neck clinically cured by buried emanation.

S. G., forty-six years, male, No. 25113.

History.—About one year ago a swelling on the right side of the neck was noticed. Very distinct swelling was present five months ago. On January 5th, the neck was opened under the impression that the mass was inflammatory. Very little fluid evacuated, and a piece removed for microscopical diagnosis demonstrated the growth to be an epidermoid carcinoma of most probably branchiogenic origin.

Examination on admission.—The right lateral surface of the neck is the seat of a large discoid swelling 9 x 9 cm. extending from the ear to the clavicle. The tumor is very hard. Over the middle of the anterior aspect of the tumor mass is a discharging sinus, 1 x 3 cm., which leads into a deeply excavated cavity.

Treatment.—January 10, 1918. 1049 mc. filtered through 2 mm. lead and placed over the tumor at a distance of 10 cm. for 18 hours.

January 12, 1918. 49 mc. in small glass tubes embedded in the mass.

February 11, 1918. Tumor less than half the original size.

March 25, 1918. Tumor has practically disappeared.

March 27, 1918. Small nodule on the lower portion of the neck removed. This showed epithelioma. No evidence of any return of the disease to date. (June, 1919.)

CASE 6. Large metastatic tumor of the neck, secondary to primary carcinoma of the tongue, reduced to a small cystic mass by combined surface application and buried emanation.

P. H. G., fifty years, male, No. 26101.

History.—Denies syphilis. In April, 1917, noticed a small ulcer on the right border of the tongue opposite the first molar tooth. This caused very little trouble until the

early part of 1918 when it became painful and made swallowing and speaking difficult. In April, 1918, the involved portion of the tongue was resected, and the glands on both sides of the neck were removed by Dr. John Erdmann. The resection of the tongue was done by cautery. Subsequently a collection of pus was evacuated from the right submaxillary space. The neck from the floor of the mouth to near the clavicle is filled by a large, hard, confluent mass. Sinus opens at the base of the mass and is 1½ inches in length.

Treatment.—Before coming under our care, he received inefficient radium treatment which produced some temporary improvement. He was admitted under our care February 4, 1919. At that time he had a hemispherical mass almost completely filling the right side of the neck. The patient was in severe pain.

Treatment.—February 5, 1919. 30 mc. embedded in minute glass tubes within the substance of the tumor.

February 6, 1919. 1546 mc., filtered through 2 mm. lead, placed over the surface of the tumor for 6½ hours at a distance of 6 cm.

February 17, 1919. Definite diminution of the pain. The tumor in the neck is softer.

March 7, 1919. Very much improved.

May 2, 1919. Tumor in the neck is about one-fourth of its original size, and is cystic. Patient absolutely comfortable. No recurrence within the mouth.

Case 7. Primary carcinoma of the antrum clinically cured by one treatment of unfiltered radium.

L. S., fifty-nine years, female, No. 25687.

History.—Patient has been frequently ill with "sore throat." Eight weeks ago noticed a disagreeable sensation in her right eye and first became aware that the right cheek and eye were swollen. This swelling has gradually increased.

Examination.—The right cheek is swollen. The right eye is inflamed and bloodshot. Epiphora is present. Within the mouth the superior alveolar process on the right side is swollen as if displaced downwards by distention of the antrum. In the bucco-gingival groove there protrudes a small ulcerated mass which is breaking through from the cavity of the antrum at this place.

Microscopical examination.—Epithelioma of the antrum.

Treatment.—July 29, 1918. Under local anesthesia the external carotid was ligated on both sides of the neck and the right antral cavity was opened by removing the superior alveolar process; 50 mc., unfiltered in glass tubes, placed in the center of the antrum and surrounded with packing; left in place forty-eight hours.

Following a period of radium inflammation and a lobar pneumonia, the patient made a good recovery, and on September 30 there was no evidence of disease present.

May 2, 1919. Still no evidence of disease present.

Case 8. Carcinoma of the rectum clinically cured by a combination of surface treatment and embedding of emanation.

M. J. R., female, forty-nine years, No. 29201, applied for treatment February 27, 1917. For the year past the patient had bleeding from the rectum. There also had been—particularly more recently—some discharge from the bowels between the bleeding. Six months ago the sensation of a foreign body in the rectum began to be felt. Two months ago constipation became very troublesome and defecation painful.

Examination.—Upon the anterior wall of the rectum is an ulcerated growth, 3 cm. in diameter. The edges are prominent and hard and nodular. The base is broad and somewhat excavated. The growth involves only one-half of the circumference of the rectum, but the wall is infiltrated to a considerable depth, forming a prominence easily felt through the posterior vaginal wall.

Microscopical examination.—Plexiform epidermoid carcinoma infiltrating the mucosa, apparently arising from cylindrical cells of the surface mucosa.

Treatment.—March 1, 1917; 364 mc. in 14 tubes of 1 mm. platinum covered with rubber and arranged in pleats of cotton

cloth, placed over the lesion and retained in place for two hours by packing, which also served to separate the opposite rectal wall.

March 2, 1917; 297 mc. in 27 platinum tubes, placed on the posterior vaginal wall over the anterior surface of the tumor for one hour. Following this treatment a rapid retrogression took place.

May 20, 1917. There was no evidence of disease.

November 10, 1917. A small isolated nodule had developed in the anterior wall of the rectum. This was removed by excision, and 45 mc. of radium in ½ mm. of silver embedded in the wound for two hours.

January 2, 1918. Recurrence of a small mass in the anterior wall of the rectum. Ten mc. in two minute glass tubes were embedded in the substance of the mass.

Following a period of discomfort, there was a complete disappearance of the mass and on April 9, 1918, a digital and proctoscopic examination under an anesthetic failed to reveal the presence of disease.

On May 9, 1919, a digital examination failed to reveal the presence of any abnormality in the rectum, and the patient was perfectly comfortable.

Case 9. Advanced carcinoma of the clitoris, urethral orifice, and anterior vaginal wall, with metastatic nodule in posterior vaginal wall, clinically cured by once embedding emanation in each mass.

J. H., forty-two years, female, No. 25283, applied for treatment March 12, 1918.

History.—Diphtheria twelve years ago. Large fibroid removed from the uterus eight years ago. Three months before application for treatment, she noticed a slight vaginal discharge, which at first was intermittent and later became continuous. Four months before treatment here, a soreness in the labia minora was noticed. Six weeks ago micturition became decidedly painful, and these symptoms have increased slightly up to the present time.

Examination.—Surrounding the urethral meatus and destroying the anterior two-thirds of the right labium minum is an ulcer 2½ cm. in diameter, with an indurated base and papillary surface. The anterior border involves the clitoris. The induration of its base is deep-seated and extends 2 cm. upward into the anterior vaginal wall.

Microscopical diagnosis.—Epithelioma of the right labium minum.

Treatment.—March 14, 1918. 11.3 mc. in five minute glass tubes embedded in the substance of the tumor; also 152 mc. in five glass tubes enclosed in ½ mm. silver, applied to the surface of the tumor in a mold of dental modeling compound.

July 2, 1918; 15 mc. in twelve minute glass tubes embedded in the substance of the tumor.

Following the first two treatments, the lesion showed a gradual improvement until July, when the ulceration was almost healed, but considerable induration remained. Following treatment in July improvement continued until January 2, 1919, when the evidence of her disease may be said to have disappeared with the exception of a small pea-sized nodule of doubtful significance in the posterior right labium. Fearing this to be a metastasis, she was treated again on January 16, 1919, 7.8 mc. in two minute glass tubes embedded beneath the nodule.

May 2, 1919. Nodule has disappeared and ulceration caused by the treatment has healed.

Case 10. Advanced uterine cervical cancer clinically cured by local application within the cervix and embedding of emanation within the tumor tissue.

G. S., female, thirty-four years, No. 25431, applied for treatment May 1, 1918.

History.—No previous illness. Menstruation regular and normal. Two children, 13 and 14 years of age. Births not difficult and no instruments used. Three or four months before applying for treatment, first noticed bleeding from vagina. This gradually increased up to the present time. Her physician first advised operation, but after having observed the condition for four weeks he referred her to us for treatment.

Examination.—The anterior lip of the cervix is completely replaced by a large fungating papillary mass, 5 cm. in diameter and completely filling the vault of the vagina. It bleeds on the slightest trauma and infiltrates the mucosa as far as the vaginal walls. The uterus is movable, but uncertain whether broad ligaments are infiltrated. The condition is inoperable.

Microscopical examination.—Papillary plexiform epithelioma.

Treatment.—May 1, 1918; 19.1 mc. in seven minute glass tubes embedded in the tumor tissue; also 191.9 mc. in three tubes of 1 mm. platinum covered with rubber inserted into the uterocervical canal for fifteen hours.

Following the treatment, there was a rapid retrogression of the tumor mass, which appeared to be complete on August 19, 1918.

May 1, 1919. No evidence of disease.

Case ii. Advanced carcinoma of nasopharynx infiltrating the soft palate and tonsil, with large metastases in the lymph nodes on both sides of the neck.

C. D., sixty years, male, applied for treatment on February 8, 1919.

History.—He has had nasal catarrh for years. Nose was broken in a severe trauma many years ago. Operated on for ulcer of the stomach in April, 1917. Two years ago a swelling developed in the lymphatic glands of the neck. In June, 1917, he developed a laryngeal voice, tinnitus, and nasal obstruction. He received treatment from a number of specialists. Finally a specimen was removed and the diagnosis of carcinoma established.

Examination.—The nasopharynx is filled by a large neoplastic mass which seems to be growing from the right side. It involves the soft palate, the posterior pillar of the fauces, and the tonsil of the right side. Large nodular fixed masses, several inches in diameter, fill the neck on each side.

Microscopical examination.—Epidermoid carcinoma.

February 8, 1919; 1979 mc. filtered through 2 mm. of lead were applied at a distance of 6 cm. for 5¼ hours to each side of the neck.

February 17, 1919; 25 mc. of emanation in five minute glass tubes were embedded in the left side of the neck; 20 mc. in four minute glass tubes were embedded in the right side of the neck; and 12 mc. in three minute glass tubes were embedded in the nasopharyngeal mass.

March 28, 1919. Inside the mouth the retrogression appears to be complete. The inelastic tumors in the neck are reduced to one-fourth their original size. The nodule in in the right side of the neck is now 2 x 4 cm. in diameter at its base, and that on the left side 2 x 2 cm.

Treatment, continued.—April 19, 1919. 7.1 mc. in five minute glass tubes embedded in the mass remaining on the right side of the neck; and 7.5 mc. in five minute glass tubes embedded in the mass on the left side of the neck.

It is impossible to give a just idea of the improvement and what it meant to the patient by a mere recital of the clinical findings before and after treatment. His physician, Dr. Farrell of Utica, who was kind enough to refer this patient to us, wrote us on April 3rd: "I am perfectly astonished and delighted with the change for the better in the condition of this patient's neck and throat. This is the first positive result I have seen from the use of radium." The right side of the neck has lost its hard infiltrated feeling and is soft and pliant. The gland on the left side is diminished from the size of an egg to the size of a nut. The growth in the naso-pharynx has melted away until only a small remnant remains in the vault.

DISCUSSION

Dr. C. H. Viol, Pittsburgh.—I regret that the illness of Dr. Simpson makes it impossible for him to discuss this paper, since I would prefer to consider only the physical side of the subject. The good reports which Dr. Janeway makes are cause for congratulation and they are in line with what we may anticipate from

the work at the Memorial Hospital where so much radium is available.

I would like to reiterate several points which Dr. Janeway has made. First, it seems to me that the advantages which are attained by the use of the emanation needles inserted into growths, may be in part attained by the insertion of needles containing the actual radium salt. In each case there is the advantage that all the radiation is brought to bear on the malignant tissue, whereas in the application of radium from without, since it is not possible to reflect the gamma rays, less than one half of the radiation strikes the malignant growth, and frequently the radiations which do not strike the growth do cause damage by their action on adjacent normal tissues. In the case of radium needles, which usually consist of a metal container, there is less beta ray action about the needle than is produced by the emanation needles which consist essentially of tiny glass tubes, and it seems to me that this is a point of some importance which will require further observation before we may know definitely whether the necrosis produced by the intense beta ray action from the emanation needles can be considered as a negligible effect.

Dr. Hugh J. Young, Baltimore.—I am very sorry that Dr. Janeway did not make his paper longer. What we need are the cases; there is too much going back into the history, and if they would give us the details it would be very helpful. The most important scientific productions are the ones which give details. The reason that Israel's book on the kidneys is so great is because he gives us details of every case. My interest in the use of radium has been largely in its use in carcinoma of the prostate, seminal vesicles, and bladder. I am very sorry that Dr. Janeway did not bring up that subject, because I know he has had much experience. We started about four years ago with a modified cystoscope to apply radium direct into the bladder, with little or no screen, and we have had remarkable results. In order to get the radium just where we wished to have it, we used a clamp and the operator looking in could see just where he wanted it and left it there. We uniformly left 200 or 250 mg. buried in the mass, leaving it for an hour, and that practically approximates your method of the needle. I think the needle is a little better because we have a little screening with our methods.

Also with the use of radium in the rectum I think the great trouble has been that the instrument used was not firm enough to place the radium just where it was desirable. Recently in London I saw the radium simply placed inside and the operator did not have any idea whether it was on the posterior or rectal wall. With the gloved finger it is perfectly easy to put the radium anywhere you wish in the rectum, and by clamping it there you know where it is. We have avoided necrosis by not putting the radium in the same place frequently. We have applied one hundred mg. twenty-five times, an hour each time, without producing necrosis. We would run up and down the seminal vesicle, and up and down the prostate, and up and down the other seminal vesicle, and never get necrosis, because we were careful not to put it back in the same place; and to be sure of this we made a chart upon which we put down each time where we made the application. We did not use any screen whatever except for a little silver and no rubber at all.

I rather agree with Dr. Clark that probably a lot of the rectal irritation has been due to the examination and not to the radium.

In regard to the other bladder cases where we were not able to use the emanation, by plunging the radium into the mass and then employing fulguration, much as Dr. Pfahler has employed the method, we have found this very effective in large tumors of the bladder. Whether they are actual carcinoma or not, it is impossible to say, but they are unquestionably cases that would have become malignant. The use of fulguration is of very distinct value in supplementing radium. The two work together very well, and the electricity added to the rays is certainly a very valuable adjunct. I believe instruments can be easily constructed by which emanations can be placed in the tumor and not taken out until the tumor is removed. I have had some made very small, which the patient might easily pass out through the urethra. I think it would be easy to bury a lot of these in the tumor and then let the patient void them afterwards.

Dr. W. L. Clark, Philadelphia.—Mr. Chairman: I have heard no remarks on laryngeal cancer, but I have used radium recently in some cases which have been the cause of a great deal of worry. I have used the electrothermic method, but the result was not good; but by using radium we are much encouraged. A tracheotomy is always done as a preliminary

procedure; and about a week or ten days afterwards the larynx and tongue reflexes are destroyed by cocain, the patient is given morphin, five needles are introduced in a brass receptacle covered with rubber, and the patient's reflexes being destroyed and the patient made comfortable by the morphin, the needles are placed in position and kept in for six hours. In one case the breathing was very labored and examination revealed an extensive growth in the larynx. He first took three massive doses on the outside followed by the radium inside. The man returned in three weeks very much improved, the growth very much lessened, and we have him another treatment at that time.I saw him a short time ago and there is apparently no malignant tissue left. He has gained considerably in weight.

About the hemorrhage in tonsil work, I have used radium in tonsil cases a great deal, sometimes supplemented by the electro-thermic method. We had one fatal hemorrhage about the fifteenth day. We have not had many, some slight ones, but this perhaps has been more good luck than good management. Here is the procedure we have adopted. If the external carotid was ligated at the time of the operation, or if we expected sloughing out from the use of the radium, the collateral circulation would be established and we would get our slough anyway; but our practice now is to wait ten days, for it will not bleed until the slough comes away. Further, the organization will have taken place, and if we do the ligation then we believe the hemorrhage will be less likely than if we do the ligation at the time of the operation.

Dr. D. T. Quigley, Omaha.—I think we do not need to go to so much trouble as Dr. Clark does in getting at the larynx. In a tubercular case treated recently we simply sat the patient down, put some seven per cent cocain into the larynx, and put 60 mg. of the element covered with thin rubber into the larynx. The bulk is not large enough to obstruct breathing and the patiently usually has a two-hour dose each time. At the first treatment the patient cannot stand the thing in the larynx very long at a time. These patients sit up; they do not lie down at all. They can only stand the tube in for about ten minutes the first time and then cough up the tube, but it can be replaced in a few minutes. The radium is kept in by having the wire well wound with adhesive tape and he bites on it. After it is in the larynx, we take an x-ray picture to see that it is in the proper place. Another way is to put a piece of Wilemite over the place in a darkened room. The second time we find that they can hold it about twenty minutes, the third day half an hour, and after that they can keep it in place for two hours, and we then give them a two hour treatment whenever they need it. We figure on keeping this up until the case is cured. I have found that the larynx will stand as large a dose as the skin, and we have no trouble with edema of the larynx.

In the application of radium in the rectum, at first we had a good deal of trouble in holding the thing where we wanted it in the rectum. I presented to the Society last year a thing that I suppose most of you have forgotten, and I will tell you about it again. Place the radium on the handle of a dessert spoon—you can feel just where you are putting it, bend the bowl of the spoon around so that it lies on the buttocks or on the back. It will stay where it is put and there is no trouble about holding it in place. This method is also successful in holding the radium in the mouth and in the throat, as I explained last year.

Dr. Albert Soiland, Los Angeles.—I came here this morning full of pep and enthusiasm. I was the possessor of 200 mg. radium element, and nearly bursting with pride and self-consciousness. Now the scene suddenly changes. Dr. Janeway has spoken, and the verdict is radium emanation. This means $100,000 plus. I am turning my face west and homeward, a sadder but wiser man.

Dr. Henry H. Janeway, New York.—We have used buried emanation very successfully in the rectum and also in the bladder. I have been able to bury emanation tubes in the bladder. The tubes are very small, only one-fourth mm. in diameter and 3 mm. long, and the needle by which they are introduced is so slender that it will go through the catheter tube of a catheterizing cystoscope and so flexible that it can be bent up at an angle by the bridge of the cystoscope and thus introduced into the tumor. The subject is so broad that I cannot take it up fully.

I do not think it is necesary for Dr. Soiland to throw away his 200 mg. of radium. He can do successful emanation work with that amount but more successful work with 250 mg. of radium, and you will find that the use of the emanation will probably enable you to do more work.

FURTHER COMMENTS ON RADIO-ACTIVITY*

By ALBERT SOILAND, M.D.

Fellow American College of Physicians, Prof. Roentgenology College of Physicians and Surgeons, University of Southern California.

LOS ANGELES, CALIF.

SINCE the last meeting of this Society, at which time the writer was permitted to present an article on the physics of radium and roentgen rays, he has made an effort to elaborate on these subjects in order to bridge the chasm which unfortunately exists between the radium therapist and the roentgenologist. In order to arrive at some medium ground for comparison, a few photographic experiments have been carried out which will serve to illustrate the text and which will be presented in the shape of lantern slides at this meeting.

To make a comparative study between radium and roentgen rays, one must approach the subject without a vestige of bias. It is only too true that the out and out roentgenologist frequently belittles and sometimes maligns radium. The writer has also heard radium therapists say many unkind things about the roentgen rays. It frequently happens that a roentgen operator with a most complete and efficient installation will deny any virtue whatsoever to radium, largely because he has been unable himself to secure any results from the small radium capsule he bought in Paris or Vienna fifteen years ago. Again, we have seen Radium Institutes in which an almost unlimited amount of this precious element was available, where upon a dusty shelf could be seen a little old one-cylinder *x*-ray machine, which from time to time was aimed at a patient; and it is safe to say that no human being could even guess, much less scientifically determine, just what sort of an *x*-ray was being ground out.

There is no need to extol before a scientific body such as this the virtues of radium; yet the sum total of success or failure with this potent element depends in a very large measure upon an intelligent conception of the laws of radio-activity coupled with a basic knowledge of human pathology. The same is, of course, true with roentgenology.

In the present attempt at a comparison of the two agents, the writer craves the indulgence of the audience if some of this is ancient history to you. The matter, however, will be covered as briefly as is consistent with an intelligent presentation.

To make a comparative rating between a single massive roentgen exposure and a single one with radium would involve many factors and render such a task exceedingly difficult. In a functionating *x*-ray tube, we have a potential source of radiant energy, much greater than in any given quantity of radium available for therapeutics. To establish a standard technic under such conditions, one would be compelled to reduce the *x*-ray output in an individual unit to a degree that would correspond to a standard radium equivalent. The next step would be to use suitable filters to insure radiation of the same wave length and frequency for both agents. Then if the time element of exposure could be harmonized, it would make absolutely no difference which agent was employed. In such an exposure with either agent, the tissue changes would be exactly alike, both clinically and microscopically.

At present, a standardization as just outlined is impossible, and we shall have to confine ourselves to discuss radium in the amounts usually available for practical work. Outside of a half dozen large Eastern institutions, this would range from 100 to 200 milligrams element.

In roentgen therapeutics, the ordinary setup of a Coolidge tube, working on 100 K.V. pressure, with 5 m.a., at an 8 inch skin distance without filter, will produce an intensive erythema or surface reaction sufficient to destroy a superficial epithelioma in a single five-minute application. As even this short exposure has been found to produce

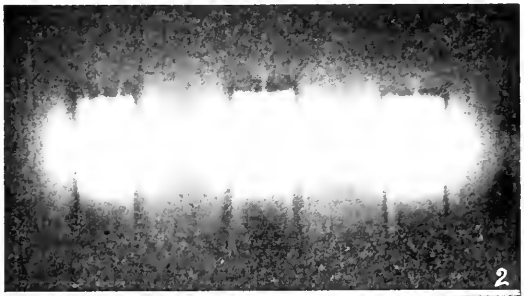
*Read at the Third Annual Meeting of the American Radium Society, Atlantic City, N. J., June 5, 1919.

lasting x-ray dermatitis in susceptible individuals, such an application is undesirable in skin work, so this dose is normally used for its deep effect on underlying tissues, employing opaque filters to screen out the rays that produce the surface irritation.

To obtain the same action as just outlined with say 100 milligrams of radium, we would have to apply this element or emanation for several hours over the skin to get the therapeutic effect; and if we desire a deep effect, heavy filters would be necessary to cut out the preponderant radium beta or short range rays, and then an exposure of a great many hours would be necessary to permit the gamma rays to functionate in a manner equal to the five-minute x-ray exposure already noted.

Bearing this in mind, and recalling that radium's greatest source of energy lies in its preponderance of beta radiation or short range rays, it is easy to understand why a radium dermatitis is more evanescent than a roentgen dermatitis. A radium dermatitis is just like an intense solar erythema. It appears quickly, is quite superficial, hence heals readily. Exactly the same sequence

Fig. 1. Roentgenogram of Hand, Made at 40 ft. Focal Distance. 100 K.V., 6 inch back up. 40 milliamperes. 10 seconds Exposure.



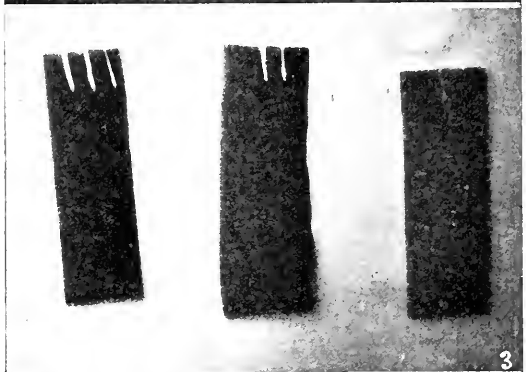


Fig. 2. Three Tubes Radium Element, 25 milligrams each, Contained in Original Silver Tube, no other Filter, Placed over Lead Strips One, Two and Three Millimeters Thick, Respectively. All Placed on Light Proof Photographic Negative. Exposure One Hour. Note limit of visible radio-activity, also actinic shadows and secondary ray effects.

Fig. 3. Lead Strips Placed on Negative Underneath Patient. X-ray Exposure of 25 Milliampere Minutes with Coolidge Tube, so called Erythema Dose Applied to Surface. Note intensive reduction of silver on negative not covered by lead, also clear cut shadows of these.

Fig. 4. Lead Strips Placed on Negative Underneath Patient. Exposure through Body. One Hundred Milligram Hours Radium Element. Note incomplete actinic action on plate emulsion, and rather dull shadows of lead plates, the latter due to secondary ray effects in the lead.

would follow an exposure by a so-called soft x-ray tube working under low voltage.

In this example, the x-radiation produced would resemble the usual radium beta radiation. Photographically, the foregoing statements can be readily demonstrated. At a 48 inch distance from the plate, 150 milligrams of radium, exposure five minutes, produces no demonstrable chemical change in the emulsion. This demonstrates that no appreciable beta radiation reaches the plate, and that the gamma rays pass through the emulsion sensibly unchanged. Placing strips of lead on plate and repeating experiment, but increasing time to ten minutes, shows a slight fogging of the emulsion due to the induced radio-activity in the lead strips. The same experiment carried to one-half hour's exposure with a fresh plate shows the shadows more clearly.

Performing the same experiment with an x-ray exposure at the same distance, the emulsion of the plate is blackened with the shortest exposure we can make, viz., one-sixtieth of a second. With radium (200 mg.), distance 10 feet, no image was obtained by either primary or secondary rays in one hour's exposure.

In order to ascertain the distance at which a serviceable x-ray plate could be made with an ordinary exposure, we rigged up a tube and plate to get the greatest space possible in our laboratory. This measured 40 feet from anode to negative. An exposure of 10 seconds, 50 milliamperes, on a 6 inch back-up, gave us a serviceable plate, that is, where bone detail can readily be seen, attention being directed to the fact that the total x-ray energy used was quite ordinary in amount. The photographic experiments were made under working conditions as nearly alike as possible. Thus the average amount of radium used at an ordinary treatment rarely exceeds 100 milligrams element, and for all the plates made at working distance, this amount is used. In the long range exposures, 150 and 200 milligrams element are employed. The x-ray plates were made with the regular standard Coolidge tube settings.

Photographically, it is almost impossible to demonstrate the difference between the dermatitis produced by x-rays and that from radium. This is due to the inability of the sensitive emulsion to register ordinary color changes.

Every competent roentgenologist and radium therapist can show slides and give case records of a great many lesions cured; therefore no time will be consumed in an elaboration of this kind now. It would be of considerable value, however, to know how many failures would ensue out of a certain number of like conditions treated by both roentgen and radium therapy. The test then becomes one of personal ability, for with ample radium one can duplicate the effects of roentgenization and vice versa.

The writer believes that the x-rays offer decided advantages in the treatment of lesions covered by, or affecting, the epithelium. On mucous membranes or in cavities where soft tissues predominate, radium becomes the element of choice. This is particularly true in lesions involving the mouth and upper respiratory tract, the vagina, uterus, and rectum.

In conclusion, from an abundant practical and clinical experience with both roentgen and radium radiation and with a fairly well balanced conception of the limitations of each of these potent agents, the best results in general are obtained by a judicious combination of both.

DISCUSSION

Dr. Douglas Quick, New York.—I do not know that I can add much to the discussion except to compliment Dr. Soiland on the very excellent paper he has given us. I think he hit a very good note when he spoke of bridging the gap between the x-rays and radium. Unless the operator has a very large quantity of radium and a very good working x-ray apparatus I do not see how he can correlate them at all, but if it is worked out along those lines I think we shall get along better therapeutically and have less and less misunderstanding than at present. Correlating the action of radium and x-ray is a very great subject. Have you made any comparison of filters? I presume that the x-rays are unfiltered and that radium is filtered

up to a certain point. [Dr. Soiland said the glass was 1½ mm. 6.] I think the results are most interesting as showing that the skin effect is not the same. On the other hand, it gives us a loophole of which, from a technical standpoint, we can take advantage through treatment. Frequently we find someone who will use x-rays and radium equally, using the application to a different part, whereas both applications are valuable if we can apply them. At the Memorial Hospital we have used the two methods and prefer the radium where we can get at a localized bulky mass, supplementing that with x-rays over the regional glands as far as possible. It is possible in these bulky masses to imbed radium emanation tubes that will produce radiation in all directions, by which you get the diffuse effects of the radium deep throughout the tumor and are also able to apply the x-rays over the surface, so that you get the rays from the front door and the back door and have the effect from both. I think we can use Dr. Soiland's findings to good advantage. We like to use the radium wherever possible on the localized and bulky lesions and supplement it as far as possible with the deep roentgen therapy.

Dr. C. H. Viol, Pittsburgh.—Several years ago it was my opinion that the radium effect on tissues was quite different from the x-ray effect, and I recall my astonishment in talking with Professor Millikan of Chicago, when he said that theoretically the effect of these radiations on tissues should be very much the same. Due to the differences which we observe, for example, in burns from radium and from x-rays, I was inclined to doubt his statement; but thinking the matter over in the light of what little we know regarding the action of the rays and the nature of the burns which they produce, it seems that we must go back to the opinion that these rays differ rather in a qualitative than in a quantitative way. Beta rays do not penetrate far and consequently are likely to produce circumscribed superficial burns, which, as we all know, heal fairly rapidly, this type of burn being the one most frequently encountered in working with radium. When using the x-ray we have in effect a very soft gamma radiation, capable of producing burns to a greater depth than in the case of the beta rays, and burns not infrequently involving a considerable area of tissue. Under these circumstances, with a considerable involvement of tissue, repair is likely to be slow, and with the peripheral nerve terminals involved, the lesions will be painful. In the case of a gamma ray burn from radium, due to very serious overdosage in the application of radium, the effect will involve a considerable depth of tissue and may or may not be circumscribed as to the area involved. Such burns are very slow in healing and exceedingly painful, but fortunately are of rare occurrence. I have known of one such burn in my experience at Pittsburgh, and this has persisted for a number of years and has so far resisted all treatment.

With these points in mind it seems to me that the argument about the difference in burns is really no sound argument at all, and the difference in therapeutic results between x-rays and gamma rays can as well be accounted for by the difference in modes of applications, etc., assuming that the effects of the rays are qualitively of the same nature, as by the assumption which many prefer, namely, that rays are inherently different in their action. In the x-ray we have enormous amounts of energy in the form of radiations less penetrating than the gamma rays. Dr. Soiland's picture, taken 40 feet from the tube, shows this plainly, and consequently great care must be taken in using the x-ray, to control the enormous energy which comes into play and which is capable of producing such bad effects when improperly applied. The action of radium is essentially local, so that when employed in a malignant growth it exercises its main effect in the malignant tissue, and the surrounding tissue is less likely to be affected, due to the falling off in the concentration of the rays. A few centimeters make an enormous difference so far as the concentration of the radium rays is concerned. All of this leads me to believe that as time goes on we shall come more and more to the conclusion that the action of the x-rays and gamma rays is qualitatively the same but quantitatively different, due to the difference in penetration of the types of rays and the limitations of the technique in applying these forms of radiant energy.

Dr. Isaac Levin, New York.—I do not think that the the difference in the action of the radium and x-rays on a photographic plate offers any criterion as to their respective biological action. Biologically there is a qualitative difference not only between radium and x-rays, but as my recent experiments have shown, be-

tween different kinds of x-rays. The white blood cells are the most sensitive of any animal tissue to the action of x-rays. I did, in cooperation with M. Levnie, a series of experiments with the turtle, which has about 90 per cent of lymphocytes, and only 7 to 10 per cent polymorphonuclears. When two turtles are placed one on top of the other, and x-rayed simultaneuosly, then as a result of the treatment in the upper animal the lymphocytes are reduced from over 90 to 19 per cent, and in the lower from over 90 to about 50. In another series of experiments there was placed instead of the upper turtle a layer of meat or a dead turtle. In this series the destruction of the lymphocytes in the turtle was equal to the amount in the upper turtle of the first series. I can conceive of only one explanation of the results: The particular type of the rays which destroyed the lymphocytes of the upper turtle is absorbed by the cells and there is not enough left to act on the lymphocytes of the lower turtle.

The dead turtle, or a layer of meat, does not absorb any of this particular type of rays, and the whole amount acts on the only living turtle of this series of experiments. The same has been shown by physicists to be true in regard to the action of x-rays on various metals. There is ample evidence in radiotherapy that the so called "soft rays" act differently from the hard rays. A burn is much more readily produced by soft rays than by hard ones. A pencil of rays consists of different types of rays, from softest to hardest. The harder the latter the more types of rays can be obtained, and therefore the better would be the selective therapeutic results. I recently devised an x-ray machine by the aid of which I believe harder rays may be obtained for therapy than with the coil or an ordinary interrupterless machine. The particulars will be reported in the near future.

Dr. C. H. Viol.—So far as I know from the physical aspect there is nothing to indicate selective absorption of the gamma rays in the manner mentioned by Dr. Levin. Absorption of such short length radium as x-rays and gamma rays is bound up with the atomic nature of the absorbing substances rather than with the molecular structure, and since the tissues involved would have the same atomic constituents when dead as when alive, I cannot comprehend Dr. Levin's observations in turtles. Since this single experiment stands in opposition to other physical evidence I should be inclined to withhold judgment on Dr. Levin's experiment unless repetition might confirm the results. I am not convinced that his observed results might not be due to differences in the technique rather than to the selective absorption.

Dr. Albert Soiland, Los Angeles.—I want to thank Dr. Quick and the other gentlemen for their kindly and frank discussions. We are working somewhat at a disadvantage out in my country, owing to our great distance from medical centers, and hard experience becomes our main teacher. We cannot quickly summon council and compare notes, as you Eastern men can. I have been doing active roentgenology and some radium work for nineteen years, and one of my early cases of epithelioma of the lip treated with radium has remained well for fifteen years. That is to show you that I have had some experience, and am not altogether a tyro in this work. I cannot well compete in discussion of radio-physics with such men as Dr. Viol, who have every convenience at their disposal for physical, clinical, and biological experiments. I believe there is no difference between the x-rays and radium provided you speak of these two in the same wave length and frequency, but that is something that the average radiologist rarely does. The roentgenotherapist has a much harder thing to deal with than the radium operator. The x-rays change and vary in intensity all the time and can hardly be standardized, while the radium man has an apparatus which delivers a certain amount of ray energy of definite strength all the time. When the x-ray man learns more about stabilizing his wave forces, and the radium man learns a little more about the effects of his own agent, result will be accomplished which are at present impossible.

THE TECHNIC OF RADIUM APPLICATION IN CATARACTS

By ISAAC LEVIN, M.D.

NEW YORK CITY

IN a paper entitled "The Action of Radium on Cataracts," presented by Martin Cohen and Isaac Levin at the Ophthalmological Section of the American Medical Association on June 12, 1919, it was indicated that in incipient cataracts the lenticular opacifications may become diminished under the influence of radium. Should a cataractous lens become matured subsequent to radium treatment and should an operation then be required, no technical difficulties will present themselves. It was also proven by the authors that the application of radium is harmless to the normal tissues of the eye. In view of these results it is probable that before long many radium therapeutists will be called upon to treat cases of incipient cataracts with radium. In order to form a true estimate of the value of this method of treatment, it is imperative that a correct and uniform technic be developed.

The first requisite for the correct handling of the cases is the constant cooperation of an ophthalmologist. The latter has to make a correct diagnosis and decide whether the case is suitable for radium therapy. Furthermore, the ophthalmologist has to examine before the beginning of the treatment the visual acuity of the patient and make accurate drawings of the lenticular opacities and of the fundus details. Then at stated intervals these ophthalmological investigations should be repeated throughout the course of the treatment.

As to the technic of the radium application *per se,* one must obtain an idea of the aim to be accomplished in order to conceive the correct method. The capsular epithelium is most probably the starting point of cataract. The precipitation of the soluble ingredients within the lens which result in the formation of the opacifications cannot take place without a change in the structure of the capsule which acts as a barrier membrane. Since the capsule is a product of cell life, the change in this barrier membrane must be due in the ultimate analysis to an abnormality, in either the structure or the functions of the capsular epithelium.

It is proven biologically and clinically that the hardest beta and mainly the gamma rays of radium exert a selective action on abnormal cells. In tumors and granulomata, the action of the rays consists in the inhibition of the proliferating capacity of the cells; in conditions like Graves' disease, it influences and alters the functions of the cell. It is *a priori* possible that the radium rays may alter the capsular epithelium, so as possibly to render the whole capsule less permeable for the abnormal agents within the general circulation or in the neighboring tissues which upon entering the lens produce the opacifications; or else the change in the membrane may consist in its enhanced ability to exosmose certain substances out of the lens. The lack of the latter substances may result in formation of opacities.

The alpha and soft beta rays of radium act only as a general caustic, and it is a commonly accepted principle in radium therapy that unless the radium be inserted within the tumor or the abnormal tissue, the correct treatment of the abnormal conditions which do not lie directly on the surface of the skin, is that only hard filtered rays should be employed.

It is remarkable that in ophthalmology, even in the most recent publications, the methods reported still consist in the application of soft unfiltered rays. Koster (cited by A. F. Mattice, *Arch. Ophth.,* 1914, Vol. XLIII, p. 237), who treated with radium a large number of cases and a great variety of eye diseases, used a glass tube filled with radium which he placed uncovered and unprotected in any way directly upon the scleral conjunctiva. Knox, in his latest edition of Radio-Therapeutics, still recommends exposures with unscreened radium.

*Read at the Third Annual Meeting of the American Radium Society, Atlantic City, N. J., June 5, 1919.

Such methods are dangerous, since the soft unfiltered rays irritate and burn the immediately adjacent normal tissues—conjunctiva, cornea—without influencing the deeper lying abnormal tissue, the cataractous lens.

The method employed by the writer in the treatment of cataracts is similar to the technic of deep radium therapy which he is using at present in the treatment of malignant tumors and various other conditions.

A glass tube containing the radium salt or the radium emanations is placed in a brass capsule 1 mm. thick. The capsule is covered with about 2 cm. of thickness of black photographic paper and as much gauze. The whole is placed over the closed eyelid. The applications lasts two hours and the quantity of radium used equals about 25 mg. element. At the beginning of the treatment much larger quantities of radium were employed without injury to the eye, but the smaller quantities appeared to be quite as effectual. The treatments are repeated at first every week, and later at longer intervals, in accordance with the results of the ophthalmological examinations. The treatment once in two to four months should be continued for at least two years, since the cataract is a slowly developing disease.

Other operators, as well as the writer, will undoubtedly modify and improve the methods as the work goes on and in a few years the results should be checked and a definite conclusion reached as to the value of this method of treatment of incipient cataracts.

DISCUSSION

Dr. H. K. Pancoast, Philadelphia.—I would like to ask Dr. Levin if the dosage he gives causes any change in the conjunctiva.

Dr. A. S. Fleming, Minneapolis, Minn.—I am not sufficiently familiar with the pathology of cataracts to discuss the probable effect of radium on their development; but inasmuch as radium applied to immature eyes and embryos has resulted in the production of cataracts and optic nerve atrophy, I would like to ask if injury to the retina or optic nerve has been observed in these cases.

Dr. C. Everett Field, New York.—I have one case which was sent to me by a doctor who had heard of radium being used in such cases. Although this was five months ago we did not know of the technique and the doctor did not know where he had heard of it. We made two ten minutes' applications of twenty-five mg. with the lid turned back and in all the man, in five months, has had two treatments averaging six weeks apart. There has been a distinct improvement of the condition, no increase of the cataract film, and the case is perfect. My dosage is very light, and yet it was given with one-half millimeter of gold. There was no surface irritation and the man's vision is improved. He was blind in the left eye and we are working on the right eye. If there is anything of curative value in these cases it will be a splendid thing.

Dr. Isaac Levin.—Every question asked here is answered in the paper of Martin Cohen and myself referred to in my presentation. As is stated in my paper, there was no irritation or any other ill effect upon any of the other structures of the eye. I employ about 25 mgs. The glass tube is encased in one mm. of brass and the latter covered with black photographic paper and gauze to make two cm. in thickness of each. The application is continued for two hours. In the future, all workers on this subject should try either to follow closely the methods of Martin Cohen and myself, or else clearly state in their publications what variations of the method were used, so that when the results are checked up later the results may be compared.

INFLUENZA PNEUMONIA FROM A CLINICAL AND X-RAY STUDY*

By JOSEPH HARKAVY, 1st Lieut., M. C., U. S. A.,

And JOHN HUNTER SELBY, Major, M. C., U. S. A.

Chief X-ray Section, Walter Reed General Hospital

TAKOMA PARK, D. C.

IN the early part of September, officially September 15, 1918, the influenza epidemic, which was spreading through the country, insidiously and relentlessly, first made its appearance rather dramatically in the Observation Ward for Infectious Diseases at this Hospital. The patient, a corps man, gave a history of short onset, distinctive of an acute nasopharyngeal infection, except that it was more intense, and died two days after admission with a left-sided bronchopneumonia.

Thereafter cases appeared with great regularity, the number steadily mounting, as shown from the daily survey in Table 1, until it reached its crest on October 9, 1918. On that day, there were 650 cases of influenza in the hospital. Then came a sharp decline which continued throughout the month of November, with a secondary rise, apparently temporary in character, during the month of December, 1918.

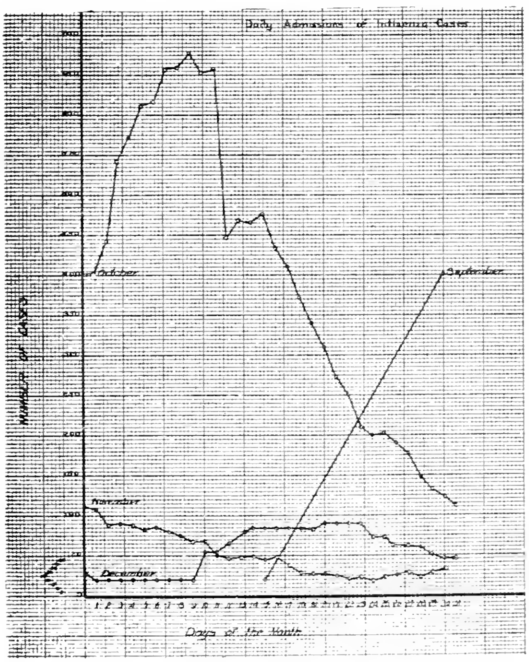


Table 1. Daily Admissions of Influenza Cases.

Analyzing the number of admissions according to months, we find the following:

Admissions from	*Influenza*
September 15 to October 1, 1918 . .	420
October 1 to November 1, 1918 . .	1066
November 1 to December 1, 1918 . .	85
December 1 to January 1, 1919 . .	256
January 1 to February 1, 1919 . . .	198
February 1 to March 1, 1919 . . .	53
Total	2078

Coincident with the influenza cases, the number of pneumonias presenting themselves were thus, divided according to the admission diagnosis:

	Broncho Pneumonia	*Lobar Pneumonia*
September 15 to October 1, 1918	58	6
October 1 to November 1, 1918	199	23
November 1 to December 1, 1918	21	0
December 1 to January 1, 1919	256	2
January 1 to February 1, 1919	53	0
February 1 to March 1, 1919	2	1
Total	589	32

The mortality rate varied with the rate of admission and time of the year. Thus it is readily seen that during the height and virulence of the epidemic, the deaths entirely due to the complicating pneumonia or its sequellae were greatest in September and October, gradually diminishing in November, December and January.

The three cases admitted during February had been sick for a long while before admission; hence the high mortality.

*Read at Twentieth Annual Meeting of The American Roentgen Ray Society, Saratoga Springs, N. Y., Sept. 3–6, 1919.

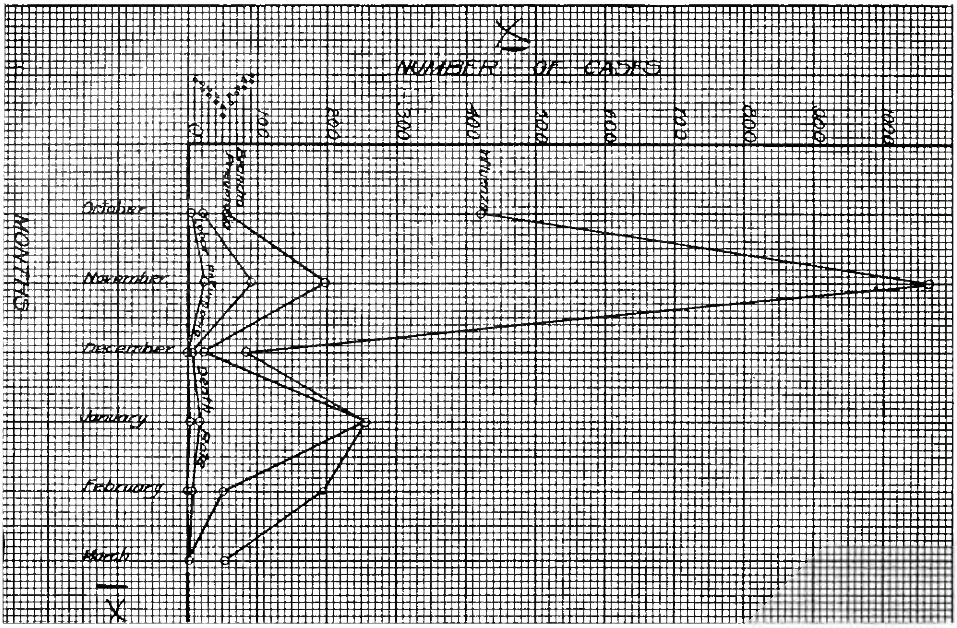


TABLE II. COMPARISON OF ADMISSIONS OF INFLUENZAS, BRONCHO AND LOBAR PNEUMONIAS, AND DEATH RATE.

	Pneu-mo-nias	*No. of Deaths*	*Per-cent-age*
September 15 to October 1, 1918	64	22	35
October 1 to November 1, 1918	222	91	41
November 1 to December 1, 1918	21	5	24
December 1 to January 1, 1919	82	18	22
January 1 to February 1, 1919	53	9	17
February 1 to March 1, 1919	3	2	66

In the study of the epidemic as it presented itself at the Walter Reed General Hospital, it has been deemed best to analyze it from the following points of view:

1. Acute influenza and sequellae.
2. The influenzal pneumonias from a clinical and *x*-ray point of view.
3. Sequellae and complications.
4. Pathology and bacteriology.

I. Influenza

In making this survey, 700 cases of uncomplicated influenza have been studied. Nearly all were in soldiers from camps in the vicinity, for which the Walter Reed is the post hospital. A fair proportion was made up of detachment men, nurses and doctors. No one was immune. Apparently the young and vigorous and those who were most active succumbed more readily and not infrequently with a greater fatality than the comparatively weak and less active.

Onset.—The period of invasion varied from one to five days, the average being two and six-tenths days. It was characterized in 20 per cent of the cases by a feeling of general malaise, pains in the lumbar region of moderate severity, and body fatigue. Various degrees of prostration and the sensation of physical inadequacy were prominent, as were also chilliness combined with a rising temperature and sweating on the least exertion. Such symptoms, however, were often not sufficiently marked to cause the vigorous soldier to go on sick report. It was only when the onset was ushered in by a severe and sudden chill, which occured in 75 per cent of the cases, when the fever frequently coming on at night was high, when it was associated with severe frontal headache, dizzines, photophobia, lacrimation and marked restlessness, that admission was sought.

The general appearance of the patient in

the early period of the epidemic was marked by extreme prostration—a prostration out of all proportion to the physical findings. He lay huddled in bed, oblivious to surroundings, face flushed—suffused with a pink cyanosis. He complained of pains, especially in the lower part of the back, varying in intensity and extent of distribution. At times, these pains were marked in the upper and lower extremities. They were referred either to the joints or bones themselves, or to the muscles, cramp-like or persistently dull in character. Initial vomiting was not infrequently observed. Continuous nausea accompanied by the sensation of a lump in the epigastrium was a notable feature in the more severely toxic, as well as in some of the milder cases. Sore throat, differing in severity, was complained of by all; difficulty in breathing and stuffiness of the nose accompanied by an irritative cough were present in 80 per cent of the cases. These initial symptoms prevailed to a greater or less degree in every patient, especially at the height of the epidemic.

Detailed analysis of the symptoms and clinical features has resulted in a classification of these cases in three groups:

1. Early severe cases, presented a temperature of onset which varied between 104° and 105° F. The fever rise was acute, reaching its climax within eighteen to twenty-four hours and, as a rule, did not persist at that figure for more than one day. During the second twenty-four hours it reached only 102° F., gradually coming down by prolonged crisis or lysis within three to four days, average 3.7 days, to sub-normal.

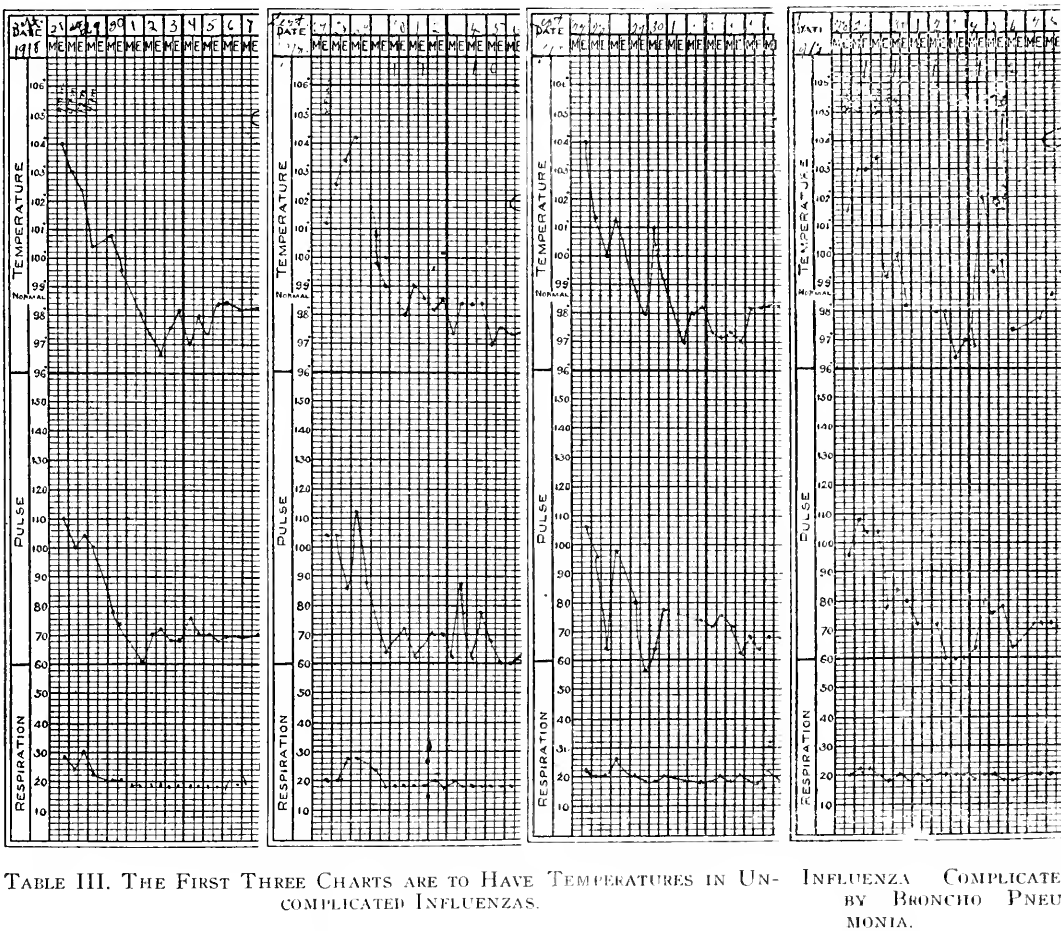


Table III. The First Three Charts are to Have Temperatures in Uncomplicated Influenzas. Influenza Complicated by Broncho Pneumonia.

Among these, however, there were 10 per cent of cases especially noted during the months of December, January and February, when the virulence of the epidemic had spent itself, where the initial high fever terminated by a crisis within twenty-four hours. Correspondingly the toxemia was brief, and the prostration, although quite as severe as in the early cases, rapidly recovered from. This type of case seems to be more common in sporadic outbreaks which occur during different periods of the year.

2. The second group, moderately acute cases, ran a temperature between 100° and 102° and similarly reached its termination by prolonged crisis, or lysis, of from three to four days. Although the temperature was not so high, the toxemia was, nevertheless, not markedly lessened, and the subjective symptoms were not at all ameliorated.

3. The third group, mild types, and abortive types with temperatures between 99° and 99.5°, without acute subjective symptoms of a sudden infection, composed a most interesting class of cases. The patients gave a history of general weakness which lasted off and on for a week or more. They complained perhaps of a slight coryza, headache, or moderate pains in the back, at the end of a day's work. This was associated with some sweating during fleeting periods of stress, loss of appetite, or listlessness, and finally they could go on no longer.

On admission into the hospital, the lack of dominating symptoms created the impression that the patient was only slightly if at all ill, raising a doubt in the diagnosis of influenza. It was only after daily, careful examination of the chest that it was discovered, on about the fourth or fifth day, although there was no rise in temperature, pulse, or respiration, that pulmonary signs were present at one or another base of one of the lungs, most frequently the left. The question which of course arose in certain instances, was whether there had not been some deep focus of involvement in the lung, impossible of detection on admission until it came towards the surface, and the prostration observed, quite in contrast to the temperature, dependent on a latent preexisting pulmonary condition, undiagnosed. But of course not all of this group developed physical signs—2 per cent in all. The others gradually got better without untoward symptoms within five to seven days.

Respiratory Symptoms.—Coryza was present in 70 per cent of the cases. It should be noted that it rarely reached the exudative stage. It was distinguished rather by a tenseness of the nose and frontal sinuses associated with anosmia. Extreme dryness prevailed throughout the nasopharynx and trachea, the patient often lying with his mouth open to avoid the discomfort of breathing through a stuffy nose. The stridor accompanying respiration through inflamed nasal passages annoyingly obtruded itself during physical examination.

Inspection of the oral cavity presented distinct features. In the highly febrile cases a uniform injection prevailed throughout. The inner surface of the cheek had an intense scarlet hue; the soft palate, pillars of the fauces, uvula, tonsils, and pharynx, with its swollen adenoid tissue, were all a vivid cerise. The uvula was especially engorged and looked like a flaming baggy pendulum swinging in the hot breath. The tonsils were not swollen, nor was there ever an exudate visible. The distended interlacing blood vessels over the soft palate formed a curious blue-tinged mosaic upon a hyperemic background, and abruptly terminated at the juncture of the hard palate by a grayish line of demarcation. The entire picture impressed one as if the door of a blazing furnace had suddenly blown open.

Hoarseness was present quite frequently. In some cases it was noted on admission, but most often it developed when the patient's fever began to decline. Examination of the pharynx under such conditions was practically negative, except for some muco-pus running down in streaks. Laryngoscopy revealed congested vocal cords and, in a few instances, slight ulcerations. Dyspnea was seen only in those with high temperature.

Cough existed in the majority of patients. Somewhat suppressed, short, and jerky in

some, frequently dry and harassing in others, it was associated with a tickling in the throat and substernal sensation of tightness. This sense of constriction about the anterior or sides of the chest was found in 80 per cent of the cases. It was accompanied by a generalized bronchitis in 10 per cent of the patients. On the other hand, not infrequently a few scattered crepitating râles at the right or left base were audible, and especially at the angle of the left scapula. Such congestive signs were practically free from change of breath sounds except perhaps for slight diminution, which always set one on guard for an impending bronchopneumonia. In cases that normally reached their termination in three or four days, these would completely disappear in twenty-four hours.

The sputum in such instances was occasionally blood-tinged, but later on the epidemic was mucopurulent in nature. Hemoptysis was conspicuous by its absence in straightforward cases of influenza.

Circulatory Symptoms.—It was quite a striking fact that the pulse in this disease was entirely out of proportion to the height of the fever. The average rate in our series was 99. Common observation was that with a temperature of 103°, the pulse ran about 100 to 110.

TABLE IV: WARD 15

Temperature	*Pulse*	*Temperature*	*Pulse*
102	90	102.8	100
101	110	100	98
104	115	103.8	112
101.8	85	102	92
105	120	103	115
101.8	88	102	98
104	120	103	112

The character of the pulse was soft, tension rather low. Blood pressure, as a rule, ran on an average of systolic 105, diastolic 65, viz:

Systolic	*Diastolic*
120	70
110	60
90	55
100	60
100	65
110	70
95	60
100	60
100	65

Irregularities were rare during the disease, only five patients in all showing a trigeminal and bigeminal pulse.

The heart presented arrythmias but rarely. Cardiac outlines were normal. There was no enlargement due to dilatation, although of course pre-existing hypertrophy was not infrequently detected. The muscular quality was good, and except for an occasional systolic murmur at the base in the pulmonic area, which was not transmitted, no abnormalities except those previously present were observed.

Associated with the general low vascular tone, the vasodilation and consequent generalized widespread congestion of mucous membranes, especially of the nasorespiratory tract, epistaxis of greater or less severity occurred in 12 per cent of our early cases. It was debilitating in the extreme, especially after repeated bleeding, which was apt to occur at the height of the epidemic. Later on this phenomenon almost entirely disappeared. There were also seen, in the female patients, many instances of premature menstruation, as well as menorrhagia and metrorrhagia. All of these, with the super-imposed toxemia, were alarming to the patient. Repeated blood examination for coagulation time showed no abnormalities, eight minutes being the average.

Gastrointestinal Symptoms.—The onset with frank abdominal signs was infrequent. Nausea and vomiting, as has been mentioned, were not only confined to the periods of invasion, but lasted for two or three days with diminishing severity in the very sick. The vomiting was persistent, the patient being practically unable to keep anything down, for even water induced retching. Diarrhea and abdominal pains were observed in eight cases. The pain was diffuse, and abdominal examination revealed moderate generalized tenderness and some rigidity without definite localization. Examination of stools showed no evidence of intestinal hemorrhage.

The tongue was coated and moist in most instances, dry and beefy in others; not at all distinctive.

Nervous Symptoms.—Headache, as was

indicated, accompanying the period of invasion, described by some as boring in character, by others as feeling as if their heads were held in a vise, was present throughout the greater part of the disease, gradually subsiding with the fever. It was situated back of the eyes, and radiated to the base of the skull, in all probability due to involvement of the sphenoid sinuses. In a number (17) of the cases who subsequently came to autopsy, where it persisted even after the development of pneumonia, some of the sphenoid sinuses showed a hemorrhagic exudate, others the presence of muco-pus The frontal sinuses in these cases were comparatively rarely involved.

Insomnia, when present (and it was not infrequent), was accompanied by marked restlessness, during which the patient tossed about in bed continuously. This alternated with a somnolence that caused the invalid to be irresponsive, necessitating frequent and louder repetition of questions. Confusion of ideas was seen, but not often. Delirium and signs of meningitis unaccompanied by pulmonary manifestations, occurred in three of this series. One, on subsequent recovery, gave a history of epileptiform convulsions followed by unconsciousness, and a doubt arose as to the correct diagnosis.

Cutaneous Manifestations.— Erythema was pre-eminent; in the very sick, it was intense and universal. On pressure of the skin, it was readily blotted out, only more quickly to reappear on release of the fingers. Most evident on the face and chest, it was not infrequently tinged with a purplish hue, which invariably presaged a pulmonary complication. In the presence of marked toxemia this served as a warning sign for vigorous stimulation. In such cases quite early were noted small acne-like papules on the chest and back, especially over the sternum, which, however, may have been due to an irritation of the skin accompanying the sweats to which the patient was subject. On subsidence, a fine scaling was occasionally observed.

Sweating was indeed a common finding; 95 per cent of the cases presented this phenomenon. In many it was profuse, drenching in character; in others, though less marked, equally debilitating.

Urticaria occurred in 1 per cent of the cases, especially marked over the lower extremities, and most often seen after the temperature had come down to normal. In two cases it was followed by multiple arthritis and peri-arthritis, simulating peliosis rheumatica. The joints involved were the ankles, knees and shoulders, their appearance, with the swelling and redness, strongly suggestive of the conditions familiar in that disease. Herpes labilis was evidenced in 10 per cent of the cases.

Jaundice obtained in two patients, and the question here arose whether we were dealing was the so called intestinal form of influenza, although no abdominal features presented themselves.

Petechiae were noted in only two instances.

Eye Symptoms.—The eyes in 95 per cent of the cases presented acute, conjunctival congestion. In the very toxic, the only way one could describe them would be to say that they were cyanosed. This condition was associated with photophobia, but not often with lacrimation. Being part and parcel of the general infection, it gradually subsided with the amelioration of symptoms.

Ear Complications.—In analyzing the ear complications, it was deemed best to present the figures based on the examination of 1534 cases, some of them having pulmonary involvement, during the periods of September 17th to November 8th. Captain Howard examined most of these cases. During this period of the epidemic there were 37 ear compilcations, as follows:

Otitis, externa, diffuse, unilateral				1
" media, acute, catarrhal,			unilateral	14
" " " "			bilateral	3
" " subacute suppur.			"	1
" " acute "			unilateral	10
" " " "			bilateral	5
Mastoiditis " "			unilateral	3
Total				57

Otitis externa started on the fourth day of the disease. Complications ranged from the fourth to the twenty-third day, average, ninth day. One case occurred on the third day. Nine cases of acute otitis, suppurative, unilateral, ranged from the fourth to the twenty-fifth day; one case of bilateral on the fourth day, and another on the eighteenth day.

The bacteriology of suppurative otitis media yielded the following results:

Staphylococcus albus, occurred 7 times
H. S. & Staphyl. albus occurred once.
H. S. & Friedlander, occurred once
Sterile culture occurred once.

Sinus involvement, in this last series, was not a very prominent feature. Clinically, the following types occurred:

Number of patients with sinus complications	6
Sinusitis, acute, catarrhal, frontal, right	2
" suppur. " " bilateral	2
" acute " maxillary, right	1
Pan-sinusitis, acute, suppur.	1
Total	6

making .0033 per cent of cases.

One of the acute frontal cases started on the 18th, the other on the 24th, average, 26th day. The case of maxillary sinusitis occurred on the 4th day and pan-sinusitis on the 10th.

Tinnitus was noted occasionally. Impairment of hearing occurred in the early cases, but was associated with toxemia rather than with actual lesions in the auditory apparatus.

Genito-urinary Symptoms.—Albuminuria was present in 6 per cent of the cases and reported usually as a faint trace, or trace. Occasionally a heavy trace was encountered, but that proved to be the exception rather than the rule.

Casts were associated with albuminuria, and recorded as few hyalin or occasional granular. They were not often found, however. Leukocytes were also observed occasionally.

Hematuria was seen in two cases. No cystitis or pyelitis was observed. Frequency of urination, however, during the height of the fever obtained.

Arrested cases of gonorrhea recurred with the onset of temperature, and the usual discharge proved quite a problem in the matter of ward sanitation.

Blood Findings.—Leukopenia, reported by numerous observers, was also a striking feature in our series. In the early cases the average count varied between four and six thousand. The differential was normal in some; in many cases a relative lymphocytosis with a corresponding decrease in polynuclears predominated. Occasionally the total white count went as low as 2000. During the latter part of the epidemic, especially in the months of December, January and February, a distinct change occurred. The total count was decidedly higher, and the polynuclears on the increase. Counts varying between 15000 and 18000, with 84 to 86 per cent of polynuclear cells, were commonly seen. Concomitantly the resistance of the individual increased, while the incidence of the dread complication of pneumonia diminished.

Sequellae.—The sequellae of influenza as such are rather difficult to dissociate from those which occurred after influenza with a possible slight pulmonary complication. It is well recognized, as will be demonstrated later, that it is not always so easy to state absolutely that we are dealing with a straightforward case of influenza and nothing else. As far, however, as could be judged, we have endeavored to record the consequences following cases of influenza, uncomplicated.

In our study it has been apparent from the beginning that the nervous system had been most vulnerable and had suffered most. General weakness, persisting for from three to four weeks, in some individuals under observation from two to three months, has been particularly conspicuous. The entire constitution, as it were, had received a terrific shock. As one boy described it, he felt as if "all his pep had been knocked out of him." Many lost weight. Myasthenia on slight exertion was extremely prevalent, especially in the first two weeks of conval-

escence. General irritability, lack of ability to concentrate, mental depression, insomnia, headaches, often prevailed. Neurocirculatory asthenia, with its cold hands and feet, sensations of precordial distress, cardiac irritability, and all the variegated gamut of the neurasthenic syndrome, repeatedly presented themselves.

Probably the most interesting group of cases that have come to our observation during the epidemic have been the seventeen in whom neurological complications first manifested themselves consequent upon an attack of influenza. Most of these had a constitutional predisposition, and influenza served as a touchstone which fired dormant affections. Of these, three cases developed dementia precox of the hebephrenic type, in whom the prognosis is doubtful. Nine exhibited toxic psychosis, with its usual train of symptoms—confusion, disorientation, erotic type of delirium, hallucinations, paranoid delusions. All of these recovered within six to eight weeks. Three developed psychosis of the manic-depressive type. Two of these were manics; one depressive. Of the former, one has recovered, the other two are still under observation but improved. Two cases developed a psychoneurosis. Both of these had a typical history of constitutional psychopathy. These also are greatly improved.

The last factor which has stood out in this study, aside from the most important complications, has been the lack of immunity in some of the cases to recurrent attacks of influenza. It has been observed in twenty of this group, most of whom had two attacks within an interval of two weeks to three months during the epidemic. It was especially prevalent among those who had gotten up early, or had simply had at first an abortive or mild attack, and returned to their duties. The second attack, although mild in some, in others was much more severe and resulted in bronchopneumonia of greater or less extent.

(To be concluded in the March issue)

TREATMENT OF PRURITIS ANI BY X-RAY RADIATION

By WILLIAM J. YOUNG, M.D.

LOUISVILLE, KENTUCKY

AMONG the more troublesome local lesions, and perhaps the most intractable, pruritus ani stands in the first rank. How often are we confronted by patients suffering from pruritus ani who have run the gauntlet of all kinds of doctors and of known remedies, receiving temporary relief from each change, only to have the intolerable itching recur with added force!

From time to time there has appeared in medical literature an article with statistics describing a new method of treatment which appeared to hold out great promise; but after a trial the majority of physicians have been forced, on account of the unfavorable results obtained, to pronounce the method inefficient and in some instances to cast suspicion upon the results claimed by the originators.

In presenting this short paper I desire at the outset to save myself embarrassment by stating that there is nothing new in the treatment of pruritus ani by means of the *x*-ray. Just what effect radiation has on the lesion is unknown beyond "thinning out" the infiltrated and thickened tissues; but certainly there is amelioration of the subjective symptoms which in some cases is lasting, thus making the treatment worthy of trial in all instances.

The etiology of pruritus ani constitutes a subject about which there has existed much divergence of opinion between various members of the medical profession, and it is still safe to say that the direct cause is unknown. Pruritus ani has for years been a bone of contention between the dermatologist and the proctologist, each claiming

that it belongs to his specialty. The dermatologist speaks glibly of a neurosis, while the proctologist insists that the trouble is symptomatic of pathology higher in the rectal canal, viz.: hemorrhoids, fissures, proctitis, ulceration, polypi, stricture, cancer, foreign bodies, prolapse, cryptitis, thread worms. In some cases there is no discoverable pathology, but the majority of the patients have one or more of the foregoing complaints. As there is usually present some lesion amenable to treatment by the proctologist, it would seem to me he should be the first to examine the patient. Should he be unable to demonstrate the presence of pathology referable to his specialty, the patient could then be sent to the dermatologist. Where rectal pathology is found the proctologist is naturally the one to institute the necessary treatment, and it has been my experience that until the lesion higher in the rectal canal has been relieved, little effect of a lasting nature is produced by local treatment of the pruritus.

In the treatment of pruritus ani during the last four years I have depended entirely upon fractional doses of *x*-ray given at weekly intervals, the dosage being governed by the infiltration of the anal tissues, from four to ten radiations constituting the treatment. In the cases treated the results have varied from temporary improvement to seeming cure. My best results have been secured when working in conjunction with the proctologist, my part consisting of relieving the pruritus while he was striving to correct the particular ailment which operated as a causative factor.

The amount of radiation and the number of treatments necessary in each case may vary considerably, and must be left to the judgment of the roentgenologist. Unfiltered doses of *x*-ray being used, the one giving them should not only be well versed in estimating the dosage, but should have a definite knowledge of the appearance of the normal skin about the anal region as well as the changes produced by the effect of pruritus and also of radiation. Nothing is further from my intention than to suggest that anyone operating an *x*-ray machine is capable of successfully treating pruritus ani. It demands one skilled in *x*-ray therapy of the skin, and if the method be used correctly the results will soon be manifest. Relief from itching is usually noted after the third or fourth dose.

My experience has been that recurrence of the pruritus depends upon the amount of rectal pathology present. Where treatment by the proctologist is necessary for one year, I give the patient six to eight treatments at weekly intervals, then a rest for three months. Irrespective of the absence of pruritus I then repeat the treatment, limiting the number of doses should there have been no itching during the interval. Usually before the proctologist has finished with the patient the pruritus has entirely disappeared. The point I wish particularly to emphasize is that in the treatment of rectal lesions attended by pruritus ani, the proctologist has a consistent and valuable adjunct in the roentgenologist. With few exceptions the patients I have treated for pruritus ani have had pathology higher in the rectal canal.

CONCLUSIONS

(1) That in *x*-ray therapy we have a valuable adjunct in the treatment of pruritus ani.

(2) That where causative pathology exists higher in the rectal canal, radiation may be successfully used to control the itching.

(3) That so long as the pathology continues in the rectal canal requiring treatment by the proctologist, the pruritus ani may persist.

(4) That *x*-ray therapy in pruritus ani should be directed by a skilled operator who has definite knowledge concerning the course of the lesion and also the effect of radiation upon the tissues about the anal region.

THE AMERICAN JOURNAL OF ROENTGENOLOGY

PUBLISHED BY PAUL B. HOEBER, NEW YORK CITY

Issued Monthly. Subscription, $6.00 per year. Advertising rates submitted on application. Editorial office, 480 Park Av., New York. Office of publication, 67-69 East 59th St., New York.

TWENTY-FIRST ANNUAL MEETING

The Twenty-first Annual Meeting of The American Roentgen Ray Society will be held at Rochester, Minn., and Minneapolis, Minn., September 15. 16, 17 and 18, 1920; at Rochester on the 15th, at Minneapolis on the 16th, 17th and 18th.

Further details and advance information concerning the meeting will appear in these columns from month to month.

Minneapolis headquarters, Hotel Radisson.

ORGANIZATION OF ROENTGENOLOGICAL SECTION IN THE SOUTHERN MEDICAL ASSOCIATION

In a manner highly satisfactory to those interested, the organization of a Roentgen Section of the Southern Medical Association was accomplished at the meeting in Asheville in October.

Letters suggesting the formation of such an organization were sent to a hastily prepared list of about eighty men doing *x*-ray work in the South, and although these letters were late in being mailed, twenty-two were present at the organization meeting, and letters and telegrams were received from others signifying their approval of the step and offering their support. It seemed to be the almost unanimous desire to ask that a Section on Roentgenology in the Southern Medical Association be formed, rather than that any new organization be attempted. A committee consisting of Dr. A. L. Gray of Richmond, Dr. O. H. McCandless of Kansas City and Dr. Robert H. Lafferty of Charlotte, was appointed to present the matter to the Executive Committee. The committee approved and formed the section. The following officers were appointed:

Chairman, Robert H. Lafferty, M.D., Charlottle, N. C.

Vice-Chairman, Dr. O. H. McCandless, Kansas City, Mo.

Secretary, Dr. J. W. Landham, Atlanta, Ga.

The Southern Medical Association has at present about 6,000 members drawn from the seventeen Southern States, and in this territory there are several hundred men doing *x*-ray work either exclusively or to a large degree.

The Association, in addition to organizing the Section on Roentgenology, also recog-

nised the roentgenologists in selecting as its First Vice-President one of the leading and best known Southern roentgenologists, Dr. Alfred L. Gray of Virginia.

The next meeting will be held in the fall at Louisville, Ky.

Lafferty.

Inter-allied Roentgenological Club

One of the outgrowths of the war was the close relations which were formed between different members of the roentgenologic services of the allied countries. About the time of the Armistice it occurred to members of the French, English and American services that these relations be perpetuated and that measures be taken to promote the good feeling and friendships which had been started. Out of this sentiment has crystallized the formation of an English roentgenologic club, whose President is Sir Archibald D. Reid, the head of the English Roentgenologic Service, and the secretary of which is Dr. Robert Knox, well known as an author. Following this movement there has been formed in America a temporary organization along the same lines, the temporary chairman of which is Dr. Preston M. Hickey of Detroit, Michigan, and the secretary, Dr. William H. Stewart of New York City. The French club, we understand, is in process of formation. The first meeting of the representatives of this international roentgenologic club will be held in the United States in the fall of 1920.

The central idea on which these organizations are being formed is largely social and in pursuance of this idea the name "club" in place of society has been selected. One of the consequences of this movement will be the furtherance of facilities for international postgraduate instruction. Postgraduate students from foreign countries will be furnished with letters of introduction from their own club, and will be given a hearty welcome upon their arrival and afforded all necessary assistance in selecting places to visit, and will be aided in the choosing of a serviceable itinerary.

It has not been the purpose of these clubs to interfere or to replace in any way the already established scientific roentgenologic bodies. The presentation of scientific programs and exhibits is already well taken care of by the various national organizations.

It is hoped that the aid which will be given to roentgenologists traveling from and to this country will repay any effort which is being made to promote good will among those of the allied countries.

P. M. H.

TRANSLATIONS & ABSTRACTS

Russ, S., D.Sc., Chambers, H., M.D., Scott, Gladwys M., Mottram, J. C., M.B., Experimental Studies with Small Doses of x-rays. *(The Lancet,* 4991, CXCVI. April 26th, 1919.)

The subject matter of the present paper consists of experimental facts as to the effects of small doses of x-rays upon the blood of rats and upon the susceptibility of these animals to tumor implantation (Jensen's rat sarcoma). An attempt is made to show the possible bearing of the salient features of these newly acquired facts upon the present-day treatment of malignant disease by means of x-rays. It will be generally admitted that in such treatment attention is usually focussed upon giving the malignant cells a lethal dose of radiation. Two suggestions are put forward here in this connection. When therapeutic doses are given to the cells of a tumor the rest of the body receives a fractional dose of the rays. It is submitted that the action of these rays, especially upon the lymphocytes in the circulation, may be deterrent to the combative forces which the patient can normally bring to bear against the tumor growth. In the second place the possibility of increasing the resisting powers of the system by means of small doses of x-rays is shown to have an experimental basis.

Exposure of a rat to a large dose of x-rays causes profound changes in its blood; the cells most affected thereby are the lymphocytes. Other blood cells are acted upon by these rays but generally to a much less extent. From the results of many experiments devised to determine the nature of the action of the x-ray on the lymphocytes, it has been concluded that the action is direct upon these cells in the circulation. The fact that the lymphocytes disappear from the circulation in such large numbers after an exposure of but two seconds leads us to doubt very strongly that this is due to their destruction, especially as they reappear with great rapidity. If lymphocytes "in vitro" be given a dose one thousand times as large as that required for these effects "in vivo," no degenerative changes are detectible microscopically, and no diminution in their numbers is observed.

A rat when given small doses of x-ray (twelve seconds) shows a 50 per cent reduction of its circulating lymphocytes one hour later; then it begins to recover, and in twenty-four to forty-eight hours is normal again. If the same dose be administered a fortnight later a similar drop occurs; the recovery is slightly delayed, but the number of lymphocytes finally reached is generally greater than at the beginning. Repeated application of such a small dose may result in a high degree of lymphocytosis.

It has been shown in previous publications that when sarcoma cells (Jensen's rat sarcoma) are inoculated into rats which have previously been immunized, the failure of the sarcoma to grow is associated with some special activity on the part of the lymphocytes. The further experimental fact acquired was that if immune rats are given a dose of x-ray sufficiently large to cause and maintain a marked lymphopenia, then such immune animals become once more susceptible to the growth of the sarcoma. These two experimental findings show that the lymphocytes play an important part in determining whether the sarcoma cells grow into a tumor or not. It appears that some mechanism is present in the immune animal which brings the lymphocytes to the sarcoma cells, and that this is absent in the normal animal. There is evidence that (1) rats showing extraordinarily high lymphocytes counts will bear growing tumors when inoculated, and on the other hand that (2) rats having little more than a normal lymphocyte content can exhibit all the evidences of immunity.

The x-rays used in the above experiments were those emitted by a Coolidge tube worked by an induction coil at a spark gap of 4 inches; no screen was used other than a thin sheet of mica covering the aperture of the tube box and a thin perforated sheet of celluloid covering the box in which the animals were placed during the x-ray exposures; the distance from the anode to the animal was 30 cm. The composite beam of rays would generally be characterized by the term "medium" or "medium soft."

1. The natural immunity which animals usually have towards the inoculation of spontaneous tumors can be broken down by an x-ray exposure sufficient to cause the disappearance of the lymphocytes.

2. The acquired immunity which results from the inoculation of blood or other cells into animals can similarly be destroyed.

3. The acquired immunity which is found in animals in which tumors have disappeared can likewise be broken down.

4. Tumor cells from a foreign species, which on inoculation will only grow with great rarity, multiply rapidly in an *x*-rayed animal until such time as the depleted lymphoid system is well advanced in regeneration.

5. Acquired immunity is destroyed only so long as lymphoid cells are reduced in number.

6. In contrast to these conditions, an immune condition can be produced instead of destroyed by suitable doses of *x*-rays. *X*-rays when administered to an animal have therefore two actions, quite apart from their direct effect upon a tumor: (a) A large dose of rays by destroying the immune condition will favor the growth of a tumor; (b) a small dose by producing the immune condition will help to control and may overcome the growth of a tumor.

The bearing of these facts upon the radiological treatment of malignant disease in man appears to us to be as follows:. Whenever a tumor is exposed to *x*-rays the lymphocytes circulating in the blood-vessels of the growth and of the surrounding tissues will be irradiated, or if the site of operation be treated the lymphocytes in the normal vessels and tissues will be similarly exposed. It is clear, therefore, that though the radiologist may be giving the primary growth the dose of radiation required for its disappearance, he may at the same time be indirectly encouraging the development of secondary growths by lowering the natural powers of resistance of the patient, especially if this comparatively large dose is repeated at fortnightly intervals, as in post-operative treatment.

It would appear profitable therefore to take all possible precautions to prevent the destruction of such cells as the lymphocytes, which, there is good reason to believe, play a defensive rôle in many varieties of malignant growth.

Finally, as regards the possibility of using *x*-rays to increase the natural powers of resistance against cancer. It must be clearly understood that up to the present it is only resistance against cancer inoculations that has been increased. Nevertheless, there is a distinct analogy between a graft introduced experimentally and a lodgment of cancer cells occurring at a distance from a primary growth. By the use of small doses of *x*-rays repeated at intervals it may be that the resistance against the development of secondary deposits can be increased in a similar way to that which occurs in the case of an experimental inoculation.

Webster W. Belden.

Gage, Harold C., Captain A. R. C. Radiographs Direct on Bromide Paper and Their Place in War Economy. (*Archives of Radiology and Electrotherapy.* No. 232, November, 1919.)

It should be understood from the beginning that the use of bromide paper to replace plates in radiography is limited. It is absolutely unsuited for fine detail and the diagnosis necessitating fine detail, such as injuries to joints, doubtful fractures, bone disease, sequestra, etc. The indications for its use which are to be considered are the two large demands made on the radiographic service which bromide paper can admirably fill, namely, the demonstration of foreign bodies and of fracture. The next demand is to verify the position of the fracture on admission to a hospital and should the patient be transferred to an apparatus for treatment by extension and suspension he will need to be radiographed in the apparatus as he lies in bed. For this work the bromide paper is ideal; sheets may be used large enough to include the articulations, with antro-posterior and lateral views on the same sheet, and in this way the results of treatment may be checked so as to give the best possible results in the alignment of the fracture. When the time comes for final results, these can be radiographed again on bromide paper so as to complete the case.

Technique—The bromide paper should be the most rapid positive paper than can be obtained (of the carbon or contrast type), and a surface about the same as that of a plate is to be preferred to an enamel surface. Intensifying screens should always be used not only on account of the reduction of the exposure, but because the print is of far better quality, being richer in detail and contrast. The tube penetration should be about 15 to 20 per cent less than the recognized penetration for plates. A tube which is too hard produces a flat and foggy print. Suitable penetration is an import-

ant factor. The exposure of course will vary with the different papers and the thickness of the part to be radiographed; it should be approximately from one-fifth to one-third of that required for a plate under the same conditions but without a screen. Development of plates with metol hydroquinone, as is usual, requires no change, for this developer works very well in developing the bromide paper. If a duplicate is required, two screens in one casette will meet the case, and little difference can be observed in the resulting radiographs. A screen may be cut in half and kept specially for the purpose; the half screens and the bromide half sheets are placed side by side in the casette, the paper lying on top of the screen on one side and the screen on top of the paper on the other. The two halves are exposed in turn, one half during each exposure being covered with lead.

The advantages of this technique are that for routine work, such as checking up on positions of fractures, etc., it is less expensive, is a permanent record to go with the patient's clinical history, cannot be broken and weighs much less than glass plates; in fact 100 sheets of bromide paper occupy less space and weigh less than 6 plates.

WEBSTER W. BELDEN.

CARMAN, R. D. The Operability of Cancer of the Stomach as Determined by The Roentgen Ray. (*J. Am. M. Assn.*, Vol. 73, No. 20, November 15, 1919.)

Without the use of the roentgen ray, a positive diagnosis of cancer of the stomach is often not made until cachexia, loss of weight, achlorhydia, obstruction, Oppler-Boas bacilli, and a palpable tumor are noted; these are all signs of advanced gastric cancer. The patient's fate depends too much on his physician's personal opinion and too little on the true but hidden conditions of the case. As many physicians have believed, and still believe, that the palpable tumor precludes operative relief, some patients whose lives might be prolonged by operation are not operated on. Others are subjected to useless exploratory laparotomies which roentgen ray examination can prevent.

The roentgenologist does not look on this method of examination as independent or ultimate, as it is only one part of a thorough clinical examination, and the verdict of operability based on its findings is only of relative value except in cases that are indisputably inoperable. The syndrome of early cases of cancer of the stomach is not sufficiently characteristic to differentiate it from that of other gastric diseases. Nor can a cellular diagnosis be made by the roentgen ray; but a filling defect may be shown which enables the roentgenologist to make a gross pathologic diagnosis in the majority of cases. An indication for operation should be recognized in the location and extent of the filling defect in the gastric contour, especially when we consider that 95 per cent of all tumors of the stomach are cancerous. As metastasis and an extended lesion prevent operation in many more cases than does the location of the primary lesion, early diagnosis seems the surest preventive of a high gastric cancer mortality; the roentgen ray has often proved to be a means of diagnosis and of forecasting the operability of carcinoma of the stomach at a time when clinical symptoms are so slight as merely to hint at malignancy.

If the roentgen ray examination reveals a tumor of the stomach, screen and plate findings should be studied with one purpose in mind—possible cure by operation. The chances for cure which the particular case possesses place it, according to the roentgen ray evidence of operability, in one of three groups: operable, border-line, or inoperable. The limits of each group are roughly marked by the roentgen divisions of the stomach: Group 1, tumors of the pars pylorica, the operable zone; Group 2, tumors of the pars media, the questionable or border-line zone, and Group 3, tumors of the pars cardiaca, the definitely inoperable zone.

OPERABLE TUMORS. GROUP 1.

In Group 1 are those tumors which are located in the pyloric end of the stomach; these are shown by the roentgen ray to be operable so far as the stomach is concerned. In this type are included those cases in which the lesion has not spread far on the stomach to the danger zone of the pars media. As approximately 70 per cent of all gastric cancers occur in the pyloric end of the stomach and as about 95 per cent of all lesions which encroach on the gastric lumen are carcinomatous, a lesion in the pyloric end should always make one strongly suspicious of malignancy. The character and size of the filling defect may also give some

hint of malignancy; but the question of malignancy which is of importance in considering the advisability of operation is of no importance from the standpoint of the possibility of operation; that depends on the amount of healthy stomach wall remaining. Often cases which present such severe symptoms clinically as to seem inoperable prove operable on roentgen ray examination, for even a large palpable tumor may be resected if it is confined to the lower half of the stomach. While a palpable tumor does not, therefore, prevent operation, it does mean that the lesion has existed for some time and that metastis may be present. Free motility of the cancerous stomach favors resectability, but signs which point to it may also be misleading. The filling defect may be atypical of cancer and the clinical symptoms alone may offer little explanation; but if the patient who has indefinite gastric symptoms has any filling defect in the contour of the stomach, whether typical or atypical of cancer, the chances are that malignant growth is present. A lesion of the stomach can be pronounced operable, however, only with respect to the stomach, as perforation and metastasis almost invariably remain undiscovered until after incision.

BORDERLINE TUMORS. GROUP 2

The tumors of the second group are those which extend so far up the stomach wall, into the questionable zone, that their resection becomes uncertain; they are classed as the border-line cases. These cases present a most puzzling problem as to operability from a roentgenologic standpoint. Their removal depends as in the cases of Group 1 on the possibility of metastasis, plus the judgment and skill of the surgeon. The position and size of the stomach may be a surgical drawback; the small high-lying stomach of the robust person offers much greater difficulty to the operator than does the relaxed stomach of the asthenic person. Therefore, if the roentgenologist is familiar with the surgeon's technic he can better form his decision as to the operability of the particular case than if he knows nothing of the operator's dexterity and willingness to attempt resection when the tumor lies in the border-line zone of the stomach.

INOPERABLE TUMORS. GROUP 3

In Group 3 are the cases of gastric tumors which are pointed with finality by the roentgen ray as inoperable. The tumors of this group are located in the cardiac end of the stomach, or they have spread from a pyloric or fundal carcinoma to within this inoperable zone. Surgery can bring no relief to the patient when the cardiac end of the stomach is cancerous. The tumors in this region of the stomach are easily recognized by the roentgen ray as inoperable.

VALUE OF THE ROENTGEN RAY

Of recent methods which have so far been adapted to discover the cancerous growth and to prophesy the chances for its removal the roentgen ray signs when correlated with clinical findings seem to be the most promising means by which operability may be increased through earlier diagnosis. So many seemingly benign lesions of the stomach prove to be malignant that the advisability of medical treatment instead of operation seems very questionable or even homicidal. Periodic roentgen ray examinations in a suspected case can, of course, be made; but if instead of retrograde changes a filling defect typical of carcinoma is noted in time, attempted operation may be too late because of metastasis.

WEBSTER W. BELDEN, M.D.

MITCHELL, WILLIAM. Splenic Calculi. *(Arch. Radiol. & Electroth.,* Lond., No. 228, July, 1919.)

In the bibliography of radiology the spleen occupies a very small place, mainly concerned with the practice of radiology in leukaemic and other conditions. In radiography it is hardly mentioned at all, except that some writers say its size can be thus determined. The writer has never seen such a condition as splenic calculus mentioned in the journals or text books, and yet most experienced radiologists must have observed them occasionally. Personally, the writer has seen from four or five clear cases *intra vitam* and on two occasions has found numerous calculi post mortem.

In the case recorded the spleen when removed showed over its antero-external surface with many snow-white plaques raised above the level of the capsule one-eighth to one-sixteenth of an inch. A skiagram made revealed numerous dense shadows, readily visible through the whole thickness of the body of a man. The author naturally considers these to be cast by the white plaques on the surface.

When they were examined no evidence of calcification or lime-salt deposit was found—the condition was due simply to thickened capsule. They, however, contained 0.9 per cent. mineral matter, consisting largely of potash salts, with minute amounts of iron and aluina. Clearly that did not account for the shadows. When examined under the fluoroscope the shadows could be clearly seen, but removal of one of the larger plaques did not interfere with the shadows, which still persisted. The shadow-producing body was removed under the fluoroscope and upon examination was found to be composed of 67.7 per cent. calcium carbonate. Of the origin and pathology the author is ignorant. Possibly they are miliary tuberculous foci which have become healed and calcified. The spleen in this case was removed from the body of a man 67 years of age otherwise quite healthy, who died of internal anthrax.

ECHLIN S. MOLYNEUX. Radium in the Treatment of Tuberculous Adenitis. *(Brit. M. J.,* London, Nov. 29, 1919.)

The therapeutic properties of radium have always been a fascinating subject, both to the medical profession and the laity, and the former has by no means reached the limits of the subject yet.

During 1913-14 the writer thought he would see what could be done by radium for tuberculous glands. As a result he is convinced that the day of radical operation will soon be past, that it will no longer be necessary to send children thus affected to the sea-side for prolonged periods, and that the unsightly scars which disfigure the necks of so many girls can now be avoided. Radium is, if properly used, a safe and—as far as one can see—a certain cure, whether for early or advanced cases of tuberculous glands. Within the period named he treated with radium between twenty and thirty cases of every grade. In every case the swellings and even old sinuses faded away. Unless there were already sinuses present, no scars were left. The skin was in some a little red for a few weeks, from the action of the radium, but this always disappeared.

In no case was any ulceration caused. It is unnecessary to describe all the initial experiments and the doses used. As a result he finds as follows:

Fifteen milligrams of radium bromide, spread out on a flat circular applicator 1¼ in. in diameter and mixed with a special varnish to keep it even and prevent loss, is sufficient for this kind of treatment. The applicator has a screen of silver 1 mm. thick and a piece of thin gutta-percha tissue tied over the whole to prevent soiling of the radium. The applicator is strapped on over the tuberculous glands. Ten hours is found to be a suitable time for each application of the above strength—that is, 150 milligram hours. The applicator is put on when the patient goes to bed and taken off in the morning. A different gland or group of glands can be attacked at each sitting till all have been covered, and the course then started again.

The patients have usually had two applications a week. Nothing was noticed for from a week to ten days, but from that time a gradual shrinkage of the glands was observed till nothing could be felt except a few fibrous nodules. He continues the treatment until all signs of trouble have disappeared. In very bad cases he usually gives in addition a few applications three months later, but doubts whether this is really necessary if the first treatment is properly carried out.

Since the writer has been demobilized from the R. A. M. C. he has had an opportunity of inspecting many of the patients he treated in 1913-14. In none of them can be found a trace of any further trouble, nor has he heard of any he has not actually seen having any signs of recurrence. Evidently,therefore, the cure is usually a lasting one. Should a case recur, he has no doubt that a further course of treatment would restore the patient to health again.

THE AMERICAN JOURNAL OF ROENTGENOLOGY

Editor, H. M. Imboden, M.D., New York.

VOL. VII (NEW SERIES) MARCH, 1920 No. 3

BONY CHANGES IN FEET FOLLOWING FRACTURE OF THE VERTEBRAE

By LLOYD BRYAN, M.D.

Instructor in Roentgenology, University of California

SAN FRANCISCO, CALIF.

BONY changes associated with nerve lesions are of frequent occurrence. The most common of these are the so-called Charcot joints—the changes in the phalanges, metacarpals and metatarsal bones in leprosy, and in cases of syringomyelia. Also Eloesser experimentally produced typical Charcot joints in cats by severing the posterior nerve roots and allowing the animals to traumatize the joints.

Little attention has been given to the fact that fracture of the vertebrae followed by sensory disturbance in the legs and feet may also be accompanied by bony changes. Therefore, I wish to present the following two cases as being of some interest to the roentgenologist.

PHILIPPINES.

CASE I.—H. H., age forty-four, native of Germany; painter by occupation; family history of no importance. He served with the American army in the Philippines for two years between the ages of twenty-three and twenty-five, and while there had malaria. Twelve years ago he had a rather severe attack of "painter's colic." Eleven years ago he fell from a scaffold three stories high upon a concrete sidewalk, fracturing his left wrist and injuring the spine. Following the accident, there was paralysis of both legs with incontinence of urine and feces, and loss of sensation in the penis and in the lower legs. The use of his legs was restored in about a month. Within a few weeks, the bladder and rectum functions were practically normal. There is now occasional difficulty when the bladder is distended, and there is also at rare intervals, incontinence of stool. The sensory disturbance in the feet and legs has not improved.

Physical examination shows no variation from the normal in the head, upper extremities, chest or abdomen; there is a slight kyphosis in the upper lumbar spine, with some limitation of motion. The thighs and knees are normal. The lower legs show muscular atrophy and the toes show plantar flexion; the second and third digits on the right foot were amputated on account of contractures three years ago, and the fourth digit on the left foot was amputated one year ago. There is a small ulcer on the plantar surface of the left foot at the base of the fifth digit. There is marked diminution of the tactile and pain sense in the penis and scrotum and around the anus, also on the posterior central region of the left thigh, and the entire left foot and ankle; on the

*Read before the Pacific Coast Roentgen Ray Society, December 6. 1919.

Fig. 1. Case 1. Lateral Plate Showing Crushing Fracture of the First Lumbar Vertebra.

Fig. 2. Case 1. Anterior Posterior Plate Showing Crushing Fracture of the First Lumbar Vertebra.

right side there is loss of sensation of the medial and posterior surface of the thigh and of the lateral posterior surface of the lower leg and the entire foot and ankle.

Roentgen examination shows a crushing fracture of the body of the first lumbar vertebra.

The astragalus of both ankles shows a flattening, with slight thickening about the superior articular surface, and a small loose fragment on the right side.

Fig. 3. Case 1. Lateral View of Both Ankles.

The left foot shows an amputation through the middle of the proximal phalanx of the fourth digit; the remainder of the phalanx is sharpened and there is a dislocation of the metatarsal phalangeal articulation.

There is also a dislocation of the third metatarsal phalangeal articulation, and there is erosion of the distal end of the proximal phalanx with a sharp spur on the lateral surface of the distal end.

The proximal phalanx of the fifth digit shows erosion of the base with slight tendency to hypertrophic change, with the distal end of the proximal phalanx narrowed and somewhat irregular as though a partial absorption had occurred.

The right foot shows an amputation of the second and third phalanges at the metatarsal-phalangeal joint; there is erosion of the head and distinct thinning and slight irregularity of the distal thirds of the shafts of the fourth and fifth metatarsals. The proximal phalanges of both these digits are markedly thin and pointed, as if partially

absorbed. There is also marked erosion of the base of the middle phalanges of these digits. Aside from the astragalus, there is no change in the tarsus or in the metatarsals, except as mentioned. The distal phalanges of all the digits remaining are normal.

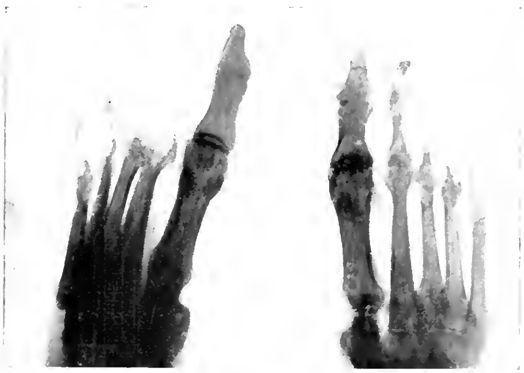


Fig. 4. Case 1. Left and Right Feet.

The roentgenograms of the hands are normal, except for old fracture of the right scaphoid.

Here, then, we have a destructive process or a process of absorption with tendency toward hypertrophic changes about the joints.

Case 2.—E. S., age thirty; laborer; single; lived in Ireland until six years ago; bridge-builder and laborer.

Fig. 5. Case 1. Hands.

Eight years ago, the patient fell from a scaffold upon his back, fracturing the spine, with paralysis of the left leg following. At the time of entrance to the hospital he had anesthesia of the left heel, posterior portion of the ankle, and plantar and dorsal surfaces of the lateral portion of the foot, corresponding to the cutaneous supply of the

Fig. 6. Case 2. Os Calcis.

external saphenous, the internal calcanean and the external plantar nerves (sacral first and second).

There was a large ulcerative area on the plantar surface of the left heel, with a sinus extending about two and one-half centimeters into the bone.

There was a kyphosis of the lower thoracic spine.

The only plate available is one of the os calcis of the left foot.

The os calcis shows marked increase in density of the lower two-thirds; the posterior plantar surface is broken up into several small fragments. There is an area of destruction extending up into the posterior portion of the os calcis. There are slight hypertrophic changes about the posterior and the plantar surfaces of the os calcis.

It will be observed that in both these cases the period since the fracture of the vertebrae has been a long one—in the first case eleven years, and eight years in the second. Both were laboring men and had continued at their work; hence there has been plenty of opportunity for trauma to the anesthetic limbs. Careful clinical examination showed no evidence of leprosy in either case.

Eloesser,[1] in his very excellent article describing his experimental work, states that trauma and lack of the warning sense

of pain are the causes of most tabic bone and joint lesions. This statement is well borne out by the results of his experiments, which showed that bone and joint lesions corresponding to those found in tabes dorsalis may be induced experimentally in the limbs of cats by severing the posterior nerve roots; the limbs subjected to the most trauma developed the most marked bony changes.

It would seem that in the cases here presented, the bony changes may be at least partially, if not wholly accounted for by the theory of repeated trauma to bones or joints lacking the warning sense of pain.

I am indebted to Dr. Harold Brunn for the privilege of reporting the first case, and to Dr. Leo Eloesser for the second.

REFERENCES

1. Eloesser, Leo H. On the Nature of Neuropathic Affections of the Joints. *Ann. Surg.*, August, 1917.
2. Gayet and Bonnet. Bone Changes of Nervous Origin. *Arch. gén. de méd.*, Par., Vol. V, 495.

PERSONAL EXPERIENCE IN MILITARY ROENTGENOLOGY OVER-SEAS

By LOWELL S. GOIN, M.D.
Associate Roentgenologist, Battle Creek Sanitarium
BATTLE CREEK, MICH.

THE writer's overseas experience was in a Base Hospital, located at Bazeilles-sur-Meuse, which performed the major part of its service while functioning as an evacuation hospital. From the standpoint of construction, the hospital was of the standard type, composed of wooden huts and of tents, and having a normal capacity of one thousand beds, capable of an emergency expansion to two thousand beds. The emergency capacity was taxed during the most of the second period of our operation. The average length of stay of all patients was four days. Many were evacuated the same day that they were received, and a certain number of fracture cases, principally fractures of the femur immobilized in permanent apparatus, were kept for a considerable period.

The apparatus furnished to the roentgen department was of the standard Base Hospital type, and consisted of a 10 K. W. transformer, a standard tube stand, Coolidge tubes, army type horizontal fluoroscope, standard vertical fluoroscope, vertical stereoscopic plate changer, a stereoscope, an army portable or bedside unit, and all the usual accessories. The horizontal fluoroscope was fitted with a detachable stretcher top, and three such tops were furnished. They proved to be very useful in moving cases from the fluoroscpic room to the operating room, when the injury was of such a nature as to preclude excessive handling of the patient. Having only direct current, we were obliged to use a rotary converter. The only one available was much too small, and limited the output of the transformer to about 7 ma. at a 5 in. gap. All of our work had to be done under these conditions; but no difficulty was experienced in producing satisfactory plates. In fact, such low milliamperage with the long exposure necessitated seems to be the ideal technique for the use of a Coolidge tube. Lacking any apparatus for immobilization, we used heavy muslin bandages fastened to the table. Even frightened Germans (and all of them believed that they were to be blinded) could be restrained with this simple device.

The roentgen laboratory was located in the operating pavilion, and was connected with the operating room, enabling us to give fluoroscopic assistance to a surgeon at any

time. When the rush of work was not too great, difficult cases were often operated on the fluoroscopic table. Fractures immobilized in permanent apparatus were examined at the bedside every two weeks without disturbing the apparatus. The army bedside unit which was used for this work was also used as an auxilliary transformer during periods of stress.

Our service may be divided into three periods. In the first, extending from May to July 15th, we functioned as a Base Hospital, and the character of our work did not materially differ from that of any large hospital. All the patients received had had previous treatment; many were convalescent, and practically none required immediate *x*-ray or operative treatment. In the second period, extending from July 15th to some time after the signing of the armistice, we functioned as an evacuation hospital. Practically all our work was done during this period. Daily reception of two or three hundred patients was common, and we received during one twenty-four hour period, 894 patients. The wounded were received directly from the aid stations, and nearly all required immediate operation. We were thus compelled, without notice, to change our entire system of receiving and handling patients. The plan adopted was as follows: The wounded were received in a shed called the receiving ward, adjoining which were some tents for the overflow, and the delousing plant. Here the patients were sorted by a surgeon detailed for this purpose, and those who required immediate operative interference were sent directly to the fluoroscopic room, where foreign bodies were localized, and fractures were reported. In order to permit the stenographer to record the findings, and to avoid turning on a white light, we cut a window in the wall of the fluoroscopic room. One side of it was covered with blue cloth, and the other side with red cloth. No light passed through this window, but the stenographer sitting beside it in the next room could plainly hear the ordinary voice. The fluoroscopic report was pinned to the patient's clothes as he passed into the operating room.

The localization methods used were the Strohl method, the Hirtz compass, and the near-point method. The Strohl was the one commonly employed, and we found it to have many advantages. With a foreign body near the surface, the near-point method is simple and fairly accurate. The Hirtz compass is really not a localizing instrument, but one for the guidance of the surgeon during operation—an instrument by means of which the roentgenologist transfers his findings to the surgeon. When carefully set up it is of great assistance to the operator, and is a nearly infallible guide. We found the fluoroscopic method of setting the compass to be the most satisfactory, but it has the disadvantage of requiring the presence of the compass. When used by the plate method, the making of stereoscopic plates has obvious advantages. The chart can be constructed from them as easily as from a doubly exposed plate, and the study of the plates in a stereoscope may yield valuable information. The Hirtz compass was found to be particularly useful in the regions of the head, chest and hip joint.

The fluoroscopic search for fractures has always been justly decried; nevertheless, under the stress of war surgery, it is not always possible to make plates of suspected fractures, and fluoroscopic examination becomes necessary. The writer's experience is that in skillful hands, screen examination overlooks very few fractures, even including partial fractures and those without displacement. The plate study of fractures is, however, the method of election.

In examining the wounded it was found necessary to examine the whole body, and it was not at all uncommon to find a projectile in an entirely unsuspected region, and where the patient was not conscious of having a wound. Undoubtedly, the most important thing to the surgeon was a report couched in anatomical terms rather than in centimeters, and such a report was always given if possible. In wounds about a joint,

the important thing was to determine the extent of the joint involvement. In chest wounds, the presence and degree of effusion is important. It was our experience that chest wounds (except sucking wounds) did better when no attempt was made to remove the foreign body. The effusion was removed, and the chest immobilized, but rarely was a search for the foreign body undertaken. A number of cases were observed where a foreign body in the lung substance was doing no apparent harm. Foreign bodies in the brain were usually removed. The accompanying fracture nearly always required operation, and the track of the projectile was often full of pieces of clothing, etc. In one such case a machine gun bullet entered through the right eye and was found lying point backward in the brain substance in the region of the fourth ventricle. It was removed under guidance of the Hirtz compass. The patient was making a good recovery when he was evacuated.

Altogether 13,440 patients were thus handled, of whom 4399 were examined by the *x*-ray. The total number of roentgen examinations considerably exceeds this figure, as all patients were re-examined under the same serial number. Fracture of the skull was found in 30 cases. Fracture of the skull was found once at operation when the *x*-ray findings were negative. Fracture of the skull was found in one case where it was totally unsuspected, and where there were no clinical findings. This case was verified by operation. The chest was examined with stereoscopic plates 246 times. Findings sufficient to justify sending the patient to a base for tuberculosis observation were encountered in 56 cases. Renal calculus was found in one case, in which case it was bi-lateral. Vesical calculus was found in one case. In general, the finding of pathology other than war pathology, was very rare, due, no doubt, to the careful examination these men received on entering the service.

The distribution of foreign bodies will be of interest. They were found in the head and neck in 98 cases; in the chest cavity in 23 cases; in the chest wall in 32 cases; in the abdomen in 15 cases; in the arm, forearm, wrist and hand in 374 cases; in the thigh, leg and foot (exclusive of the knee joint) in 5621 cases; in the knee joint 26 times, and in the back muscles 47 times. In one case a machine gun bullet in the abdomen was passed per rectum: the patient recovered. In another, a patient shot in the left cheek extracted a piece of shrapnel from the right side of the gum. We were considerably disturbed at not being able to find the foreign body in this case until the patient asked if the piece he had removed could be the object of our search.

We had wished to study with the *x*-ray the chests of persons suffering from the effects of gas inhalation, and were able to study 38 cases. The stress of work prevented us from going on with the study. In the few cases studied, fairly constant changes were observed. The chests observed were those of persons suffering from the inhalation of mustard gas, of phosgene, or of both. Cases of mustard gas inhalation showed a uniform increase in the width of the hilus shadows, and a very pronounced increase in their densities. Small, sharply defined areas of great density were seen throughout both lungs, but particularly in the upper half of the right lung. Those gassed with phosgene presented a very different picture. The smaller bronchioles were dilated, and there was a delicate peribronchial thickening observed. These changes were usually confined to the upper lobes, and were more in the upper right lobe. The peribronchial thickening did not extend to the periphery, nor into the apex. In a few very severe cases, marked bronchiectasis was found. This condition may have been pre-existing, though previous cough and expectoration were denied by the patients.

During the third period of our service, extending from November until February, we again functioned as a base hospital, the work being much like that in civil life, and without incident.

THE MANUFACTURE OF FILMS AND PLATES FOR USE IN ROENTGENOLOGY

By MILLARD B. HODGSON
Research Laboratory, Eastman Kodak Co.
ROCHESTER, N. Y.

WHILE the manufacture of any type of material demands special conditions in the factory, if the material is to be turned out in the best possible form and at the same time efficiently, the making of photographic materials—such as *x*-ray plates and films—involves considerations not met with in the manufacture of many commodities. This, of course, is due to the sensitive nature of the material.

I. Manufacturing Organization

It will be remembered that the fundamental material entering into the manufacture of photographic plates and films is silver bromide, a sensitive chemical which will not only react to light but is affected by moisture, rough handling, dirt, gases and, in fact, by almost any condition where outside energy is applied. In a factory, then, given over to the manufacture of photographic supplies, it must follow that its organization and operation preclude damage from these causes. Moreover, not only must provision be made for the utmost cleanliness and care in the actual manufacture of the finished product, but separate departments must be maintained in which the various materials entering into the making of the finished product can be produced of uniform quality, for all these separate constituents have a vital influence on the nature of the completed film or plate.

Sensitive photographic material consists primarily of two elements—the support and the emulsion. The support is either glass or a composition of nitro-cellulose, and the emulsion a dried jelly of silver bromide and gelatine. The support itself has important bearings on the quality of the finished plate or film. In the case of glass of plates, it must be free from dirt and contaminating chemicals before it is coated, and of the best quality. In the case of films, all the ingredients entering into the complicated structure of the support must be such that none of them have a deteriorating influence on the sensitive emulsion—this in addition to the necessity of quality in the emulsion itself. When it is considered that some ten or fifteen materials enter into the making of film support, it will be seen that the problem involved in this case is not a simple one.

In a plant, then, in which films and plates are made and in which the aim is high average quality, it is necessary, in so far as is possible, to make not only the finished material but all the separate constituents.

If good films are to be produced—regularly—then the film support must be made too. If the best results are to be obtained, the chemicals which develop the film for the user must be made, if printing papers of the quality necessary in portrait work are to be manufactured, then the paper stock itself must be made—and so on. Or, in case a constituent material is not manufactured outright, it must be rigorously tested and modified to insure its fitness.

In reality such a plant becomes an organization of smaller plants, each contributing its particular material made under as nearly ideal conditions as possible.

Back of this factory organization there must also be maintained a Research Laboratory where special consideration may be given to all the elements entering into the manufacture of the finished product or its constituent parts. There must be departments where the chemical nature of each of the materials used may be studied and where the reaction of one material with another may be found. There must also be a depart-

ment where such troubles as markings and defects may be taken up, their nature analyzed and remedies suggested. Finally, for progress, there must be exhaustive research on the fundamental problems relating to improvements and new methods.

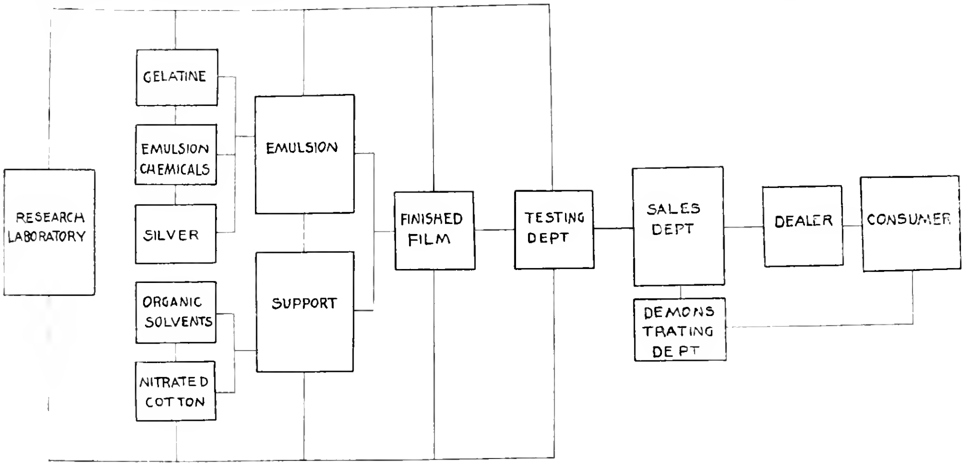


FIG. 1

There must be, in addition to the Research Laboratory, a Testing Department where the final checks on the finished products are made—under practical conditions—before they are released for sale.

The organization of such a plant may be best seen by the photograph shown in Fig. 1, which represents essentially the plan followed by the Eastman Kodak Company of Rochester, N. Y.

There are, of course, special departments which have grown up as the demand for special material developed. Such, for instance, is the X-ray Department. As an auxiliary to this there has also been established in the Research Laboratory a department of x-ray research. Here not only are the problems of roentgenology taken up with a view toward simplifying methods and developing sensitive materials and accessories which will help those methods to be efficient, but broader questions entering into the scientific development of x-ray science studied. For example, for studying the wave-length susceptibility of emulsions adaptable for roentgenology, considerable research has been done with the x-ray spectrometer. This interesting instrument is also being adapted for the study of the many crystal formations possible in the making of silver bromide, which, as has been explained, is the basic constituent of emulsions. Methods have also been devised in this department for the quantitative study of the reaction of the photographic plate to x-rays. The x-ray sensitometer, described in "The Sensitometry of Roentgenographic Materials," by Millard B. Hodgson (December, 1917, issue of THE AMERICAN JOURNAL OF ROENTGENOLOGY), was developed in this department.

II. THE MAKING OF FILMS

To the uninitiated a piece of photographic film represents nothing more than a material on which pictures may be taken, but the steps entering into the manufacture of this finished sensitive material—whether it is in the form of Dupli-Tized films, dental films, motion picture films or ordinary Kodak films—form one of the most striking examples of what may be evolved in chemical, physical and mechanical processes.

The period before the days of motion pictures is well within the memory of most roentgenologists. When one stops to consider that not only this modern institution of motion pictures but the science of dental roentgenology was made possible by the

invention of photographic film, these processes acquire an almost romantic interest.

Dental roentgenology was begun by the use of plates but was very greatly facilitated by films.

Many diversified products enter into the manufacture of each of these types of films. For example, few people realize that thousands of bales of cotton are required yearly for the making of the thin transparent backing on which the light sensitive coating is spread, or imagine that some three tons of silver bullion are used each week in the Kodak plant for making this sensitive coating. The yearly consumption is nearly five million ounces, or almost as much as the total output of silver from Arizona, one of the leading silver producing states of the Union. In addition there are sulphuric and nitric acids for use in nitrating the cotton, and organic solvents for converting the nitrated cotton into a honey-like fluid from which the thin film is made, and lastly the gelatine and chemical compounds for making the sensitive coating.

For the convenience of analyzing the various steps taken in the manufacture of Eastman film four general processes may be considered: (1) chemical preparation of raw materials, such as the cotton and silver already mentioned; (2) spreading of the support or cellulose backing in thin layers on the surfaces of large coating wheels; (3) spreading of the sensitive emulsion in thin layers on the support, and (4) slitting of large film rolls into stock sizes, inspection and packing for shipment.

In addition to cleanliness, uniformly high quality is another important requisite in photographic materials; it means that a photographer can get the same kind of results at the one time with one piece of film that he can with another piece from different stock at another time, providing that in both cases the conditions of exposure and development are the same. Moreover, to maintain a high average quality film in the large quantities necessary for present day production requires the greatest care in the selection of raw materials and repeated tests, examinations and rejections. Then again, the manufacture of a product in large batches is far different from that in small lots; it requires a complete, smoothly working organization—team work.

The campaign for an absolutely pure product commences with the treatment and selection of raw materials, and is particularly rigid in connection with cotton. After being carefully cleansed and prepared to make it soluble, the cotton is passed through a huge drying machine in order to remove the moisture which it contains under ordinary atmospheric conditions. Special machines, called nitrating centrifugals, are used to mix the cotton with nitrating acids. A nitrating machine is shown in Fig. 2, with cover raised, and consists of a large-sized perforated basket which rotates in a vat. A mixture of nitric and sulphuric acid is poured into the vat until the cotton is completely immersed. Operators, protected by goggles and rubber gloves, douse the cotton with paddles, as shown. The sulphuric acid is used to dilute the nitric acid and to absorb any moisture present in the mixture.

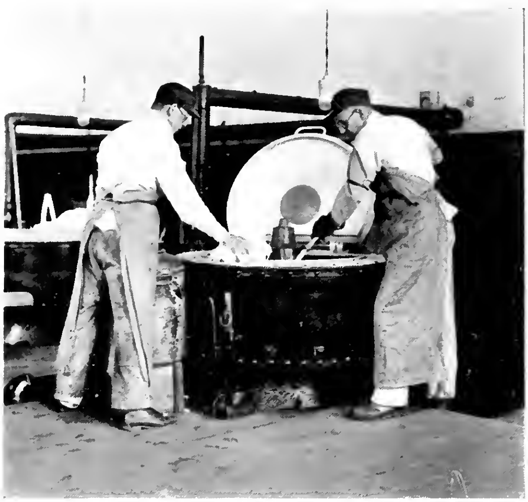


Fig. 2. Nitrating Centrifugal.

After a short immersion the acid is drained off from the cotton and then the basket is rotated at a high speed to throw out through the perforations as much of the acid as possible. The treated cotton is next removed to tanks of water, where it gets its

first washing. After being rinsed it is again passed into centrifugals, where water is played on it, and then conveyed to other tanks where it is thoroughly washed to remove all traces of acid. The excess of water is now removed and the cotton is then ready to be taken into solution by organic solvents. When it is dissolved a solution is formed very similar in appearance to honey. This, in Kodak parlance, is called "dope."

The dope is passed through a system of filters and finally spread in thin layers on huge drums, which form parts of machines each of which weighs approximately 150 tons. When dried it becomes the familiar transparent support on which the sensitive material is coated. In spite of the mammoth size of the machines, the accuracy is such that in a roll of film as it comes from the machine, 3½ feet wide and 2,000 feet long, the variation in thickness is not more than one-quarter of a thousandth of an inch from end to end. Several thicknesses of support are made, varying from the thin support used in Kodak film to the heavier type used in Dupli-Tized films.

The silver which is used to make the sensitive emulsion is the purest that can be obtained and comes in bars, each weighing about 500 Troy ounces. These are dissolved in nitric acid under correct chemical conditions, forming silver nitrate in solution, which in the next step is evaporated to crystallization. The silver nitrate crystals are next redissolved and recrystallized until all impurities are removed, a process which virtually reduces itself into a chase after that one-tenth of one per cent of foreign matter in the bullion silver. The final pure white crystals are next placed in shallow glass trays and allowed to dry under carefully controlled conditions. They are finally placed in covered jars and stored until needed.

Three stages in this process are shown in Fig. 3 (A-B-C).

III. The Emulsion

The most interesting step in the manufacture of either plates or films is in the making of the sensitive emulsion. In preparing this a solution of silver nitrate is mixed with a solution of potassium bromide and gelatine dissolved in hot water. In the reaction of potassium bromide and silver nitrate the silver unites with the bromine to form silver bromide, the potassium taking the place of the silver to form potassium nitrate. The silver bromide, being insoluble in water, is left suspended in the gelatine, while the soluble potassium nitrate is subsequently removed by washing. In Fig. 4 is shown a greatly enlarged section of undeveloped silver bromide crystals in gelatine, while in Fig. 5 is shown a section of developed emulsion showing the reduced metallic silver clots.

This suspension of silver bromide in gelatine is coated on film support or plates while still in the form of a thick liquid. Special machines have been evolved for correctly performing this operation, for it is essential that this coating of silver bromide and gelatine be put on the support at an absolutely uniform rate and that this jelly should be set rapidly by sudden chilling.

To perform this process on a commercial scale, in which thousands of square feet of support must be coated daily, requires great care and vigilance in order to produce a uniformly high quality product. In the case of films, they are coated in great rolls about forty inches wide, which must be dried before they can be re-rolled and handled. In the making of Dupli-Tized films, the first coating must be put on, dried, and the entire length rolled up before the second coating can be put on the reverse side. After these large rolls of film are dried they must be kept under uniform conditions of temperature and humidity until they are sent out to the consumer, whether they are Dupli-Tized films, dental films, motion picture films or Kodak films, and the package in each case must be designed with a view toward having them reach the consumer in the same condition as when they are made.

In the manufacture of Seed X-Ray Plates the same general type of emulsion is used as for Dupli-Tized films; that is, it is specially

FIG. 3-A. SILVER INGOTS.

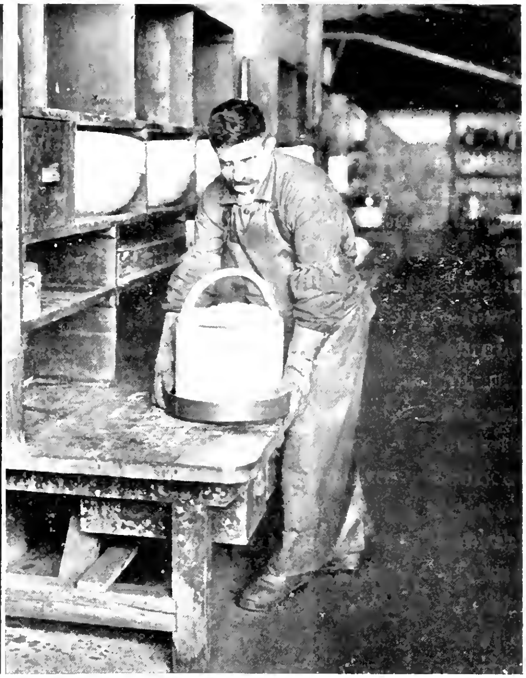


FIG. 3-C. SILVER NITRATE CRYSTALS.

FIG. 3-B. SILVER NITRATING ROOM.

prepared with a view toward having it as sensitive to x-rays as possible, its sensitiveness to ordinary light being of no special importance. The glass must be carefully washed and put in proper condition for being coated with the sensitive emulsion. After

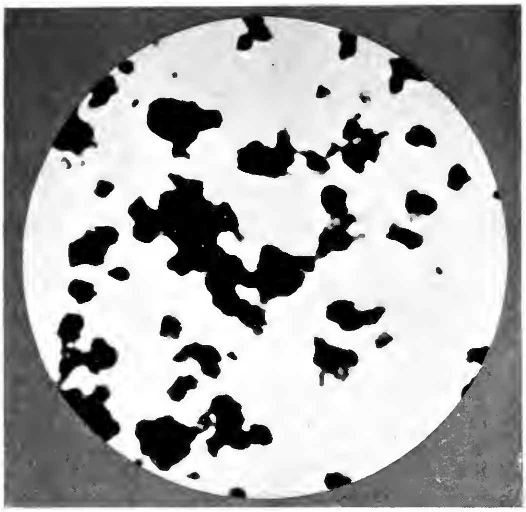


FIG. 4. SILVER BROMIDE CRYSTALS IN EMULSION.

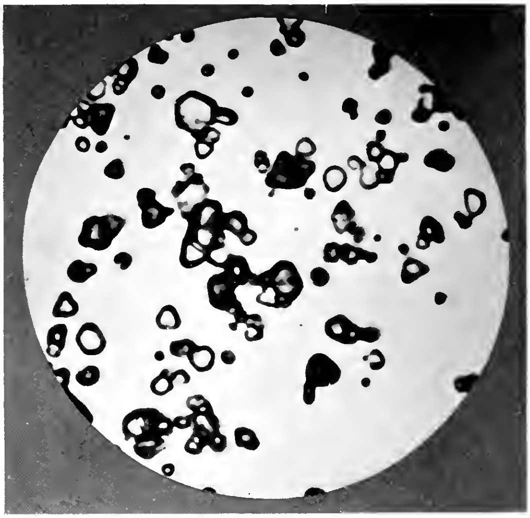


FIG. 5. CRYSTALS SHOWN IN FIG. 4 DEVELOPED TO METALLIC SILVER.

coating, the drying is conducted under conditions similar to those used for drying films. There must be a constant drying rate, otherwise a mark will show in the final negative, and it is needless to say that there must at all times be absolute freedom from contamination in the air in the coating, drying and storage rooms.

This condition, of course, also holds good in the case of either films or plates for their entire life history. Temperatures over 70° F. should be avoided where possible, as well as excessive humidity. These two are the greatest foes to emulsion keeping.

When one considers, however, the vast strides made in photographic science since the days of the old wet plate—only a few score years ago—by concerted scientific efforts, one cannot but feel that, with the even greater efforts now applied, stimulated by its war prominence as a science, photography in general, and roentgenological photography in particular, will give rise to many new possibilities.

FLUOROSCOPIC EXAMINATION IN INJURIES TO THE HEAD

By M. WILLIAM CLIFT, M.D.

Late Major, M. C., U. S. A.,; Instructor in Roentgenology, A. E. F.

FLINT, MICH.

THE head, including the accessory sinuses and jaw, has usually been considered as a field quite outside the scope of fluoroscopic technique. The enormous experience of the war has served, however, to demonstrate very clearly the usefulness of fluoroscopy in these cases. Not only intracranial foreign bodies, but small fractures, empyemata of the sinuses and minute foreign bodies in the orbit are easily demonstrated with the fluoroscope.

The author's excuse for considering this subject at such a late day is that experience has shown a distinct application of these essential military procedures to the work of civil roentgenology. It may be well to state clearly at the outset that the intention is not to urge the substitution of fluoroscopy in the examination of head cases for the ordinary procedure of stereoscopic plating. The use of stereoscopic plates in the examination of head injuries and intracranial conditions will always be the most important. However, the author is firmly convinced that preliminary fluoroscopy will generally facilitate the examination and increase its accuracy. Furthermore, the standard positions used for roentgenography of the head do not always show the lesion, particularly a depressed fracture, to the best advantage; but, with preliminary fluoroscopy, it is possible to place the head in such a position as to give the best projection on the roentgen plate.

The small radiator type Coolidge tube, because of its fine focus, produces a very clear and cleancut image which is essential in examining the head, and, together with the army table, makes an ideal apparatus for this work.

TECHNIQUE

The proper preparation of the retina prior to beginning the examination is of prime importance here, as in other parts of the body. Under the exigencies of military practice it was often impossible properly to protect the hands while examining the head fluoroscopically. This was but one of the conditions in which the roentgenologist of necessity was required to consider the patient rather than himself. However, under the conditions obtaining in ordinary civil work, there is no necessity to bring any part of the hand within reach of the active rays. It is quite possible to place the head in the position described below, turning the current on only after the hand has been removed. In making the examination of the sinuses as described in the body of this paper, the patient's head can be supported upon an air pillow, thus avoiding the placing of the hand in the path of the rays. We, therefore, feel that the question of safety to the roentgenologist, at least, is not a factor to be considered. As to the question of the exposure to the patient, it may be said that when following the routine as laid down the skull is completely gone over during a very short examination. There is no advantage in prolonging the exposure by continued observation of single areas. As one becomes experienced in fluoroscopy of the head and fluoroscopic anatomy, all that can be determined will be during a comparatively short observation. However, the total radiation given must come within the limits of safety and the danger of too prolonged an examination kept constantly in mind.

Thoroughly to explore the part and avoid the chance of missing important pathology, it is desirable to have a routine method of procedure. The following technique has recommended itself because it is both rapid and accurate. The tube is adjusted to a five-inch gap with a current of from three to five ma.

CRANIUM.—The patient is placed in the

dorsal position on the trochoscope. The head, with the face turned up, is grasped in the observer's right hand and rotated slowly from left to right 90 degrees. While rotating, the outline of the skull is carefully studied with a small diaphragm opening for the presence of fractures. When the head has reached the lateral position, the diaphragm is opened, and a general survey is made of the cranium as a whole. It may often be desirable to obtain a true lateral projection, as a foreign body is often so situated as to make it difficult to determine whether it lies in the orbital cavity or anterior fossa. This can readily be accomplished by shifting the tube until the horizontal plate of the frontal bone casts but a single shadow. The head, which has been examined in the lateral position, is now rotated back again through an arc of 180 degrees until it lies in a lateral position, a reversal of the former, and finally back to the original position with the face anterior. Thus, it will be seen, the cranium has been covered twice in the examination with a consequent reduction of the chance of error.

Fig. 1. Patient's Head in First Position for Fluoroscopy. From this position the head is rotated to the right lateral and then to the left lateral position.

Fig. 2. Position for the Examination of the Accessory Sinuses and Occipital Region (Waters and Waldron).

Accessory Sinuses.—Having completed the general survey, the frontal sinuses and anterior ethmoids are examined in the anterior-posterior position. The operator's right hand is now placed beneath the occiput and the patient's head raised until the shadow of the greater wings of the sphenoid no longer obstructs the view of the antrum. The patient is then placed in the ventral prone position and the head held so as to conform to the position described by Dr. Waters. This gives essentially the same projection as the radiographic method, although the relative position of the tube and head are reversed.

Fluid (pus or blood) or foreign bodies in the antrum or sinuses are easily determined.

Fig. 2a. Diagram of Fluoroscopic Image Obtained by the Position Illustrated in Fig. 2. *F*—Frontal Sinus, *O*—Orbit, *A*—Antrum, *M*—Mastoid.

Occasionally the overlapping of the shadows of the opposite sides gives the appearance of a foreign body. However, if the head is rotated the density of the suspected shadow

will diminish at some point during the rotation. On the other hand, a foreign body will always show the same density without relation to the position from which it is viewed. If within the sinus, the shadow of the foreign body will always show within its out-

FIG. 3. ANTERIOR-POSTERIOR POSITION FOR EXAMINATION OF THE ACCESSORY SINUSES AND FRONTAL REGION.

lines notwithstanding the position of the head.

JAW.—With the patient lying in the dorsal prone position, the head is slowly raised until the outline of one ramus shows unobstructed. Shifting the tube also assists in displacing the two sides of the jaw.

FIG. 5. HEAD PARTIALLY ROTATED TO RIGHT.

EYE.—In searching for foreign bodies in the orbit, the head is turned so that the injured eye is nearest the screen. It is then rotated until a silhouette of the lids is ob-

it, if it is intra-ocular. A foreign body lo-tained. In this position, the cornea can occasionally be seen and any foreign body located in reference to it. The patient is directed to look up and then down when the shadow of the foreign body will move with

FIG. 4. POSITION FOR THE EXAMINATION OF THE MANDIBLE. Slight variations in the angle permit a very satisfactory view of the mandibular articulation.

cated in the extrinsic muscles may also show the synchronous movement, in which case it will be difficult to establish its location definitely. However, examination in the anterior-posterior position will often clear up the situation. Throughout the examination the

FIG. 4A. DIAGRAM OF FLUOROSCOPIC IMAGE OBTAINED BY THE POSITION ILLUSTRATED IN FIG. 4. *A*—Antrum, *M*—Mastoid, X—Mandible.

smallest diaphragm opening consistent with a proper view of the area should be used.

FOREIGN BODIES.—The usual procedure for the localization of foreign bodies else-

where in the body becomes inadequate for the requirements of surgery of the head and brain. In this field the surgeon is interested in obtaining data covering the following points:

1. Is the skull penetrated? If so, the extent and nature of the fracture.

2. Is there dural penetration as evidenced by bone fragments or foreign body?

FIG. 6. EXTENSIVE FRACTURE OF SKULL DUE TO HIGH EXPLOSIVE SHELL. This illustrates the advantage of fluoroscopy in selecting the best position to show the extent and character of the fracture.

3. Is there a foreign body present? If so, what is its (a) size, (b) location in reference to the tract and anatomical structures, (c) depth? The actual mathematical depth of the foreign body is placed last in the list, as its importance is far less than an accurate knowledge of the anatomical relationship. The reason for this statement requires no discussion in view of the following statistics of Cushing covering the mortality in head injuries:

MORTALITY IN HEAD INJURIES

Fracture of the skull without penetration of the dura	30 per cent
Penetration of the dura by bone fragments or other foreign bodies but without involvement of the ventricles	50 per cent
Penetration of lateral ventricles	100 per cent

The above statistics, quoted from memory, are substantially correct.

To obtain the best results, the roentgenologist must establish a close liaison with the surgeon and must adapt his methods of procedure to the subsequent surgical requirements. In cases of recent injuries the surgeon will prefer to work from the wound of entrance; accordingly, the localization should be made in reference to the site of the injury.

Experience has shown that the track of a foreign body in the brain pursues a fairly straight course. This is an important fact in determining the particular mode of procedure for localization. If then the head is rotated until the vertical ray passes through both the foreign body and the wound of entrance, the observer is practically looking down the track. With the depth ascertained by one of the various methods in common use (Strohl—26 degrees, or Roussell) the surgeon has a guide to the missile without need of skin marking.

Between the various methods for obtaining the depth of a foreign body there is little choice as far as accuracy is concerned. The writer, however, has a preference for the Roussell method. This differs from the Strohl method in the substitution of small notches in the slit diaphragm in place of the usual wires, the underlying principle being the same in both methods. The point of advantage lies in the fact that a foreign body is easily picked up and registered in the illuminated area of the diaphragm, whereas it is often difficult to make out the hazy outlines of the Strohl wires, particularly in the cranium.

One of the greatest needs has been an accurate method for determining the position of a foreign body in relation to important anatomical structures of the brain. The author has attempted to solve the problem by the use of a cross section anatomy with a key plate on celluloid, showing the lateral outline of the skull with the various sections of the anatomical plate indicated thereon. The key plate is used directly on the fluoroscopic screen, and with the depth of the foreign body acquired by the Strohl or some other method, the exact anatomical location can be quickly determined by consulting the

appropriate section of the cross section anatomy. The importance of such a method will probably be greater when applied to cases of foreign bodies remaining in the brain for long periods after their entrance. These cases will engage our attention from now on.

OPERATIVE GUIDES

Various devices have become available during the past five years to assist the surgeon in the removal of foreign bodies. In the strict sense, most of these methods are surgical rather than roentgenological. However, they represent such an important part in the work of the roentgenologist that it would appear that they should receive at least some comment in this paper. The intermittent control method of Ledoux-Lebard is of greater importance in cases of foreign bodies located in the face, jaw or neck than in the brain. Its greatest value is manifest in those cases in which the surgeon has found difficulty in extracting the foreign body, or in which its position is in the neighborhood of some important anatomical structure and it is desirable to remove the foreign body with the least possible traumatism.

With the Dessane bonnet fluoroscope the roentgenologist is able to guide the surgeon who works in a light operating room, in an expeditious removal of the foreign body. The sense of security which the fluoroscopic control inspires in the surgeon is by no means an unimportant consideration and constitutes one of its most important advantages.

Of the instrumental operative guides for the surgical removal of foreign bodies, the Hirtz compass is by far the most important. Considerable misconception seems to exist as to the indications and scope of this instrument. It must be emphasized that it is in no sense a localizing instrument but strictly a surgical guide comparable to the grooved director. The statements repeatedly made in text books and articles that the time necessary to apply the compass is prohibitive to its general use can only be explained by a lack of personal experience with the apparatus by these authors. The method of application as modified by Hirtz and Gallot, more than two years ago is so simple that it is adaptable for use in even the most advanced hospitals. With fluoroscopic technique it is possible to adjust the compass by means of the small spirit level in from three to five minutes. Certainly the time factor as here indicated cannot be considered as important when contrasted with the advantages in those cases which meet the indications for its use. Contrasted to one's impressions at first glance, however, the indications for the use of the Hirtz compass in brain surgery are rather limited. This is largely due to the fact that the surgeon is not so much in need of a guide, which in a measure is furnished by the tract itself, as a means of extracting the foreign body with minimum traumatism to the brain substance.

M. Henri Béclère has attempted to supply this need by the use of a small electromagnet in conjunction with the compass. The instrument is applied in the usual way. The obturator is then passed through the trephine opening and plunged into the brain to the depth of the foreign body. The magnet is then attached to the obturator, which is slowly withdrawn, bringing the projectile with it. The method is very satisfactory, not to say spectacular, when applied to those cases in which the foreign body is magnetizable. Unfortunately, however, it is not applicable to those cases in which fragments of bone or non-magnetizable metallic bodies are the disturbing elements. Furthermore, it is impossible to foretell conditions in this regard prior to the actual application of the instrument.

However, it is possible to adapt a simple forceps similar to that used in the bronchoscope to the Hirtz compass, which will meet all the requirements. These forceps will take the place of the central rod or obturator supplied with the instrument, serving as a means for grasping and removing the foreign body.

The compass possesses the important ad-

vantage of offering a firm support for the forceps which can be passed down the tract of the missile with a minimum amount of traumatism to the uninjured tissues. This is more important when dealing with brain injuries than in any other type of work.

In conclusion it may be well to state what might possibly have served more properly as an introduction to this paper, namely, that the foregoing discussion simply represents the outline of the writer's notes made in France at an advanced hospital devoted to the care of head and brain injuries. No attempt has been made to cover the subject in detail, but rather to present a general survey with the hope that it will serve to stimulate an interest in fluoroscopy of the head which, we believe, has a very definite advantage.

A SATISFACTORY INJECTION MEDIUM FOR THE RADIOGRAPH OF FISTULAE

By NEIL MacLEOD, M.D.

[Abstract from the *Archives of Radiology and Electrotherapy*, London, November, 1919.]

The purpose of these injections is two-fold: (1) To obtain a true estimate of their relations to bones and their extent, including those of branches and abscesses communicated with; (2) To detect the presence and nature of foreign bodies if they are preventing closure.

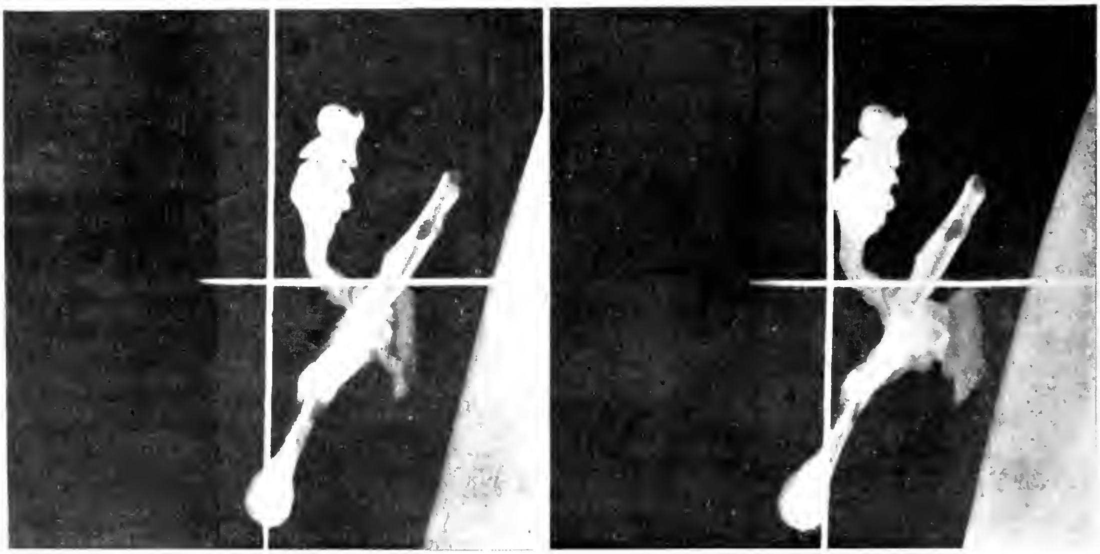


FIG. 1. Shows the result in a branching sinus containing what could be recognized as the reed. With the stereoscope the reed is seen to be foreshortened, making an angle with the plate of about 45 degrees. A bubble of air can be made out near its upper end, probably injected with emulsion. The blunt-ended shadows at the bottom and top are *cul de sacs,* the fluffy shadow on the right of the reed leading to the opening in the skin plugged with cotton wool.

The emulsion used consists of oxychloride of bismuth 1 part, and mucilage of acacia 2 parts, both materials and proportions chosen as being the best for showing the fistulous tract and abscess cavities.

The mucilage of acacia with the bismuth in suspension, when injected, apparently mixes with their purulent contents, furnishes a comparatively transparent shadow which discloses the extent of the abscess cavity and the fistulous tract, both in relation to the bones and also the relations of an empyema cavity in relation to the lungs and chest wall. It is of especial value when seen in stereo projection.

WEBSTER W. BELDEN.

DIAPHRAGMATIC HERNIA

By ALEXANDER STEWART MACMILLAN, M.D.

Formerly Lieutenant, M. C., U. S. A. Chief of X-Ray Service, U. S. General Hospital No. 1

NEW YORK CITY

AMONG approximately 15,000 cases examined in the *x*-ray laboratory at General Hospital No. 1, three cases of diaphragmatic hernia were found. It is of interest that the diagnosis in each case was first made by roentgenographic examination.

CASE I. Lt. S. Age twenty-three. While in action he received a hand-grenade wound in the left chest which fractured three lower ribs. He was taken prisoner. No operation was performed, as the injury was considered superficial. On release to an American Hospital a radiograph of the chest, which was taken to determine the extent of injury, revealed a diaphragmatic hernia. The only symptoms complained of were slight dyspnea on exertion and occasional eructation of gas. On return to this side, a fluoroscopic examination showed the meal to pass down the esophagus to below the level of the diaphragm and back into the thoracic cavity, where it emptied into the fundus of the stomach. The stomach, once full, emptied readily through the duodenum. Bismuth enema showed the splenic flexure also in the thoracic cavity. Fig. 1 shows the heart displaced to the right, and the stomach in the left chest to the level of the third rib anteriorly. The haustral markings and gas in the splenic flexure (Fig. 2) are seen to the left of the stomach, the gas bubble in the stomach being between the heart and the splenic flexure. Apparently the opening in the diaphragm was large enough to cause no embarrassment in the emptying of stomach or bowel. This patient was discharged with major disability. A month later word was received at the hospital that the patient had been operated on and died the following day. Neither the cause for the operation nor the cause of death were stated.

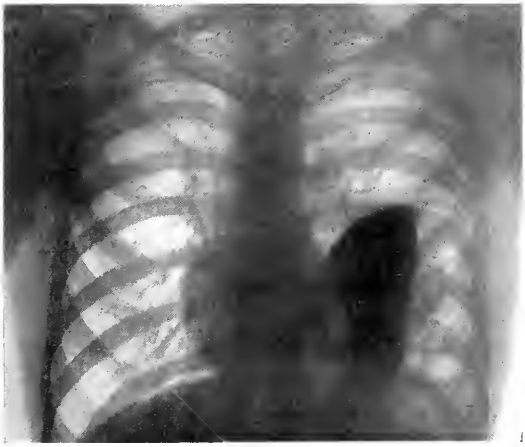


FIG. 1. CASE I.

FIG. 2. CASE I.

CASE II. R. W. Age thirty-one. While in action, September, 1918, patient received an injury in the left chest by shell fragment which fractured the 6th and 7th ribs posteriorly and penetrated the lung. Empyema developed following this injury. The pleural

Fig. 3. Case II.

cavity was drained, and by March, 1919, all wounds were healed. In May, 1919, while on sick leave in New York City, the patient was taken suddenly ill. The onset was characterized by severe vomiting, soon followed by a sharp pain under the left costal margin with general crampy pains throughout the abdomen. Nausea continued, but the patient was not able to bring up anything after the first attack of vomiting. The patient was hungry but unable to eat, as the taking of any kind of food caused severe pain in the upper left quadrant. At no time were the symptoms referable to heart or lungs. At the end of a week, as the symptoms had not subsided, the patient was removed to General Hospital No. 1. Physical examination showed a soft but retracted abdomen. Percussion of the left lower chest showed normal lung resonance above, tympany from sixth to eighth ribs posteriorly and flatness at the base. These findings could have been accounted for by a pyopneumothorax. The correct diagnosis was made by roentgenographic examination. Fig. 3 shows the stomach full of fluid in the left chest reaching as high as the level of the fourth rib anteriorly. A stomach tube was passed and 1,000 c.c. of foul, dark colored fluid removed. Laboratory reported no free or occult blood, no free or combined HCl, no colon bacilli or bile. The following day a

Fig. 4. Case II.

Fig. 5. Case II.

barium meal was given and radiograph (Fig. 4) taken which showed the meal to pass down the esophagus into the abdomen and back through the diaphragm into the stomach, none entering the small intestine. A twenty-four hour radiograph showed almost complete gastric retention. (Fig. 5.) The portion of the meal that had been retained in the esophagus had been vomited. A diagnosis was made of strangulated hernia of the stomach through the left diaphragm. Operation showed the stomach to be the only abdominal organ above the patient. The probability was that the severe vomiting forced the stomach through a small existing hole in the diaphragm which resulted in strangulation.

Case III. C. W. Age thirty-one. In March, 1919, while in France, the patient had a lobar pneumonia in the left lower lobe. Empyema followed and was drained for two months, after which healing occurred. The patient arrived on this side in June, when a radiograph (Fig. 6) was taken to determine the lung condition before discharge. It showed the stomach fluid level and gas

Fig. 6. Case III.

Fig. 7. Case III.

diaphragm, and that it had entered the thoracic cavity through a small opening in the posterior portion 4 cm. from the esophageal opening. The stomach, in good condition, as far as could be seen, was freed from adhesions and returned to the abdominal cavity. Gangrene set in and the patient died ten days later.

The cause of the hole in the diaphragm in this case could have been due to tearing of adhesions or to injury by shell fragment. No evidence had been seen of a hernia at the other hospitals where this man had been a bubble in the left chest up to the level of the fourth rib anteriorly. The barium meal showed an hour-glass stomach, the fundus being above the diaphragm and the pyloric end below. The constriction was due to the relatively small size of the diaphragmatic opening in comparison to the size of the stomach. The stomach was empty at the end of two hours. A barium enema showed the splenic flexure also in the thoracic cavity (Fig. 7).

The patient's only complaint was slight dyspnea. There was no pain in the left side

or constipation. Neither the stomach nor the large intestines showed any embarrassment by the diaphragmatic constriction. The etiology in this case could not have been shell injury, as the patient did not see action. It was either congenital or due to operation, the latter cause the more probable.

None of the three patients complained of symptoms of pulmonary or cardiac embarrassment. Digestive disturbance was noted only in the case with strangulation. In one case the stomach was the only abdominal viscus in the chest, while in the other two cases the splenic flexure also went into the thoracic cavity. The spleen and kidneys did not enter the chest in any of the three cases. The diagnosis was made in each case by radiograph. At first glance in the fluoroscope the appearance was similar to an undrained empyema except for the dome shaped gas bubble above the horizontal fluid level of the stomach with the patient in the erect position.

THE ROENTGEN RAY IN CANCER OF THE UTERUS*

By HENRY K. PANCOAST, M.D.

PHILADELPHIA, PA.

IN the treatment of any malignant condition by roentgen rays or radium or by both agents, one must carefully consider the primary growth, the avenues by which metastasis takes place, and the locations in which metastatic proliferation of cells is likely to occur. Unless all three of these danger zones are known, carefully considered, and vigorously treated, no method of treatment can be ultimately successful, except when the primary growth is discovered and attacked early, before metastasis has taken place, and all malignant cells can be removed or destroyed. In the case of the uterus this is unusual rather than the rule. One must also consider the possibility of stirring up metastasis by vigorous measures directed against the primary growth. The more advanced it is and the nearer it is to the border line of being inoperable, the more likely are cells to be disseminated through lymphatic channels to start up metastases. If the primary growth cannot be removed entirely by excision and probably by radium and other methods as well, it is likely to recur rapidly and grow and metastasize quickly.

Roentgen ray treatment alone cannot be regarded as a strictly rational measure in dealing with uterine carcinoma. Its purpose is as a supplementary procedure to follow operation or the use of radium, and it cannot, therefore, be discussed without alluding somewhat to these other measures. It can be employed as a postoperative procedure, but we believe that it is more likely to prove efficacious when employed in conjunction with radium.

Our deductions in regard to the efficacy of roentgen ray treatment following the application of radium are based upon the assumption that the use of the latter is the method of choice in those cases starting in the cervix in which the growth, however, is not distinctly limited to the cervix, but has invaded beyond. In such cases no one can be certain that invasion through lymph channels has not taken place.

It is a well recognized fact that if the growth has invaded the broad ligaments and metastasis has already taken place in the pelvic lymph nodes, radium alone cannot cure the case, usually does little more than give temporary relief from the distressing local manifestations of the disease, and may not be able to relieve the pain, especially that which is produced by nerve pressure from secondary lesions. It has frequently been stated by those who do not fully understand the action of radium, that cases become

*Read at the Clinical Congress of Surgeons, New York City, October, 1919.

worse after its use, even when it has been judiciously employed, and there may be some truth in such beliefs in many instances.

The dose of radium usually administered is the maximum one that can be given with safety and due regard for the integrity of important nearby structures. It is a well-known fact that the destructive effect of such a dose is not exerted beyond a certain definite area of a few centimeters' diameter, whereas, to be effectual, all cancer cells must be destroyed. Beyond this area the application can do no good. Although there is still considerable dissension over the question, there seems good ground for believing that too small a dose of radium, or one insufficient to inhibit cell growth, may aggravate cell proliferation. This fact should, however, not prevent its employment in cases in which the growth extends beyond the limits of possible cancer cell destruction, but it does call for any help that can be given to augment the action of the radium at the periphery of such a growth. We believe that in the roentgen ray we have a means of accomplishing this in some instances. The principle is at least sound in theory, and if not in practice, that has as yet not been definitely proven by statistics. The exact extent of benefit to be derived in this way will be difficult to determine and will require very careful statistical study.

Unless such roentgen ray treatment is systematically and judiciously carried out on the basis of a thorough knowledge of the anatomical structures involved or likely to be involved, it is a waste of time, and moreover, careless and unscientific treatment is likely to cause stimulation of cell proliferation just as is radium. In planning the procedure in each case one must consider the primary growth and its extent, the paths of metastasis and the location of lymph nodes likely to be involved. All these points must receive a destructive dose, or one that is likely to be destructive when administered as supplementary to the dose of the radium application. This is a task of prodigious proportions.

In an individual of ordinary build a maximum dose of deeply penetrating and carefully filtered roentgen rays must be introduced through seven to ten ports of entry at the skin surface in order to be in any way destructive to cancer cells in the pelvis within an area of the same or nearly the same size. When we consider the total area of possible involvement by the growth and its metastases, the number of ports of entry must be multiplied many times. Certainly thirty to fifty are none too many, distributed anteriorly and posteriorly and from every other possible direction. In stout individuals more may be required, but fortunately they possess more skin surface. Such extensive and intensive treatment is bound to exert some effect upon the intestinal tract, and may even do some harm in a very few instances; but this is not to be considered in comparison with the harm to arise from the growth.

The use of radium needles and emanation tubes around the periphery in addition to the introduction of radium into the cervix and over the central portion of the growth, is probably yielding as good results as will ever be obtained from radium. Statistics have been improving up to this time. Personally we have no statistics to offer in support of the supplementary use of roentgen rays, and the only proof of added value will have to be determined in this way from a large number of cases so treated and compared with the results following radium alone. It seems worthy of trial, but the roentgen treatment must be carried out with as uniform and accurate technic as has been employed in connection with radium.

INFLUENZA PNEUMONIA FROM A CLINICAL AND X-RAY STUDY*

By JOSEPH HARKAVY, Lieut., M. C., U. S. A.,

AND

JOHN HUNTER SELBY, Major, M. C., U. S. A.

Chief X-Ray Section, Walter Reed General Hospital

TAKOMA PARK, D. C.

[Concluded from February issue.]

II. Influenza Pneumonia

IN the review of the pulmonary involvements which followed or were associated with influenza, 260 cases were analyzed for this paper, of which 190 had been studied by daily serial *x*-rays, the standard U. S. A. bedside *x*-ray machine being employed for this purpose. A number of these cases were studied from the very day on which they entered the hospital as influenzas, when physical signs in the lungs were as yet nonexistent, others from the very moment of the first indication of pulmonary involvement. The method employed caused the patient very little, if any, discomfort. In our observations we soon learned that the predominating type of pneumonia we were dealing with behaved in an altogether distinct fashion, both from a clinical and roentgenological point of view. The intrathoracic complications which presented themselves from an *x*-ray standpoint were the following:

(1) Hemorrhagic pneumonitis involving various lobes

(2) Interlobar pleuritis

(3) Adenitis, mediastinal and peribronchial

(4) Cardiac enlargement

(5) Empyema

(6) Pericardial effusion

(7) Lobar pneumonia

(8) Diffuse mottling (so-called streptococcic pneumonia)

(9) Plastic exudate

(10) Mediastinal empyema

From a clinical study, of course, it was impossible to detect absolutely certain of these conditions, because of limitation in our methods of physical diagnosis. Thus, for example, interlobar pleuritis so frequently observed by the *x*-ray as a fine hair line of density between the lobes, never was detected by physical signs alone until an effusion took place.

Clinically, two classes of cases were encountered. First, those that ran a regular course of influenza, and then developed signs of pneumonia. Second, those in which there was a gradual onset of the pneumonia as a rule of two days' duration, characterized by general malaise, headache, beginning fever, pain in chest and cough.

In the large number of patients in whom pneumonia was a complication of influenza, this striking fact was noted. On about the third or fourth day, the temperature would drop and remain normal for one or two days. Then, without any warning, would occur a secondary rise of fever which within twelve hours reached 103° or 104°. The patient who had been feeling well for the past two days would again be prostrated.

In mild cases of either of the two types mentioned above, presenting a unilateral lesion, the temperature ranged from 100° to 103°. The pulse was characteristically slow. It was low in tension, systolic, varying between 110 and 120 and diastolic between 65 and 75. Respirations were not exaggerated, and usually 26. The average duration of temperature in such cases was five and seven-tenths days.

It was in most instances of a continuous type, with daily variations of 1 to 2 degrees. It terminated by crisis in 80 per cent; by prolonged crisis or lysis in 20 per cent.

*Read at Twentieth Annual Meeting of The American Roentgen Ray Society, Saratoga Springs, N. Y., Sept. 3–6, 1919.

Those with bilateral lesions were more severe, and the above phenomena much more exaggerated. The cyanosis which has been dwelt on as present in the very sick influenzas became a constant and familiar feature. The color varied from a marked erythemia to an almost indigo blue, especially in those whose lobes were extensively affected. Conjunctivae, mucous membranes, especially the gums, had a deep purplish tinge. The tongue was coated, the pharynx congested. Herpes were not infrequently observed. The patient often had a haunted, anxious expression. Sweating was as marked as in the uncomplicated acute influenzas. The temperature ranged between 101° and 105°. It was, in most instances, continuous in character, at times intermittent, with daily variations of two to three degrees. In certain cases one could anticipate the progress of the pulmonary involvement by the waxing and waning of the temperature curve. Thus, it would be continuous for two or three days, come down to normal, and go up again for three or four days with a fresh extension of pneumonia, finally to come down. The average duration of temperature in such cases was eight and four-tenths days. The defervescence in these bilateral pneumonias was also by crisis in 82 per cent, by prolonged crisis or lysis in the rest. The pulse here likewise was markedly slow, the lowest 85, the highest 140, average 115. Frequently, dicrotism was noted. Respiration varied between 25 and 35. Cough was frequent. Expectoration was blood-streaked or muco-purulent in nature.

Very severe types, and those which went on to a fatal termination, were toxic from the beginning. Delirium came on early and persisted until the end. Coma vigil was not infrequently observed. Dyspnea, in which all the accessory muscles of respiration were employed, was pronounced. Respirations varied between 30 and 75.

The majority were either cyanosed or had a muddy clay-like pallor. These last were more asthenic than the others. The pulmonary spread was rapid; beginning usually on the left, it quickly went on to the right and up the left, or right, until the entire lung was filled with areas of bronchial breathing associated often with moist crepitant and sub-crepitant râles, anteriorly and posteriorly. With the rapid onset of pulmonary edema everything was obscured by the stridor and bubbling râles. The temperature in such instances would be about 105°, continuously rising, and death would ensue in three or four days with fever between 107° and 108°.

The pulse presented all the characteristics of a failing myocardium. It was rapid, thready and scarcely perceptible. The heart in some instances was enlarged on the right, but most often it was impossible to detect this.

The clinical complications which those cases presented were as follows:

Nasal.—Epistaxis was present in 10 per cent of the cases; acute rhinitis in 3 per cent.

Mouth.—Gingivitis was seen in two cases. Tonsilitis was a rare complication; pharyngitis and laryngitis in 5 per cent, and ulcerative laryngitis was observed in two cases. In one, the ulcerations on vocal cords were due to a secondary hemolytic streptococcic infection. These entirely disappeared within two months.

Ears.—Otitis media, catarrhal and suppurative, and sinusitis also prevailed but in a very small percentage of cases. (This has already been discussed under "Influenza.")

Eyes.—Conjunctivitis, simple, was often evident. One case was due to the Morax-Axenfeld bacillus.

Chest.—Pleurisy with effusion, both serous and bloody, was frequently noted. Empyema, especially in the later cases, occurred eleven times; mediastinal empyema in one instance. This does not include cases that went on to a fatal issue.

Pericarditis.—Occurred more often during December, January and February. Both serous and purulent types obtained.

Heart.—Valvulitis was observed in three instances, the mitral being diseased in each case. Toxic myocarditis with various types of extra systoles and tachycardia as sequellae were present in 10 per cent of cases.

This condition cleared up in two to three months.

Gastrointestinal.—Occasional diarrhea was present. Abdominal distention with tympanitis associated with toxemia was repeatedly seen at the height of the fever.

Urinary Symptoms.—Analysis of 2000 urines showed a toxic nephritis in almost every instance. This varied from a mild albuminuria associated with few granular and hyaline casts which rapidly cleared up as the patient got well, to heavy traces of albumin and showers of all sorts of casts. Cases which presented the last terminated fatally. The blood urea and non-protein nitrogen in such instances was frequently increased. Acidosis [3] was also noted occasionally.

Skin.—Jaundice occurrd in 2 per cent of the cases.

Nervous Symptoms.—Delirium, tremors, toxic psychoses and meningism obtained in the very sick.

Blood Count.—The leukopenia, as was described, prevailing in straightforward cases of influenza, was likewise a constant feature in our pneumonia patients. The total white count ran between 2,000 and 10,000. The differential presented characteristics similar to the above cases, namely, a normal or diminished polynuclear count, with a relative lymphocytosis.

Leukocytosis up to 20,000 or 30,000 was seen in preagonal stages, when a pleuritis or pericardial involvement occurred, and occasionally with an extension of the process into other lobes. This, however, was not at all common, for frequently even to the very end the leukopenia persisted.

Physical signs associated with x-ray studies.—In comparing the physical signs which we found in the above cases with the x-ray films, certain illuminating facts come to our attention. For the sake of clarity we have divided the cases into three groups: (a) mild unilateral, confined to one lobe; (b) mild bilateral, confined to two or more lobes, and (c) more severe cases.

[3] The Van Slyke method was used in this determination.

(a) *Unilateral Cases.*—In the one lobe involvements, the physical signs would most often appear first at the lower angle of the scapula and gradually spread in a downward direction, towards the base of the lung. Where the process was mild, it would be characterized by fine and medium sized moist crepitating râles best heard at the end of deep inspiration over an area not more than 1 or 2 inches in diameter between the vertebral column and the angle of the scapula. These were accompanied by harsh breathing, suggestive of a broncho-vesicular type with practically no impairment of resonance on percussion, and no change in palpatory fremitus. Inspection presented no retractions and no immobility of the thorax. Some of these patients complained of pain in the chest, but the majority had no thoracic discomfort.

On the other hand, in the more severe unilateral cases, the crepitating râles which were early heard at the angle of the scapula, rapidly extended until practically the entire lobe was included. Within a few hours, the physical signs were completely changed. From a condition where the day before one heard a pell-mell of crepitating and subcrepitating râles, a massive consolidation succeeded. Dullness and somewhat distant bronchial breathing and no râles except at the edge of the consolidated area prevailed. Presumably it was a classical lobar pneumonia, and yet it differed entirely from the condition which we know so well. Here we were dealing not with a hepatization but rather with a bloody solidification, as we subsequently learned from our autopsy protocols, which showed that the lung parenchyma had become inundated with blood. This gave the signs of consolidation.

Out of 66 unilateral cases in this series, 46 had left lower involvement. The area affected varied from the size of a half dollar until almost the entire lobe was embraced, rarely the complete lobe such as you see in lobar pneumonia. Forty-five of these were confirmed by x-ray examinations.

Of the 22 cases in which the clinician had diagnosed a right lower lobe involvement

alone, only 9 were confirmed by serial x-ray film. In the remaining 13, the x-ray films showed a small lesion situated in the central portion of the opposite lung, or else there was in existence a small area of involvement of the right middle or upper lobe close to the hilus, so small and so contiguous to the lower lobe lesions that it was difficult of clinical differentiation. When, however, the lesion was more extensive, the physical signs closely paralleled the x-ray diagnosis.

The question which next demanded attention in this group was how often it was possible to get an x-ray evidence of pulmonary invasion before the clinical signs could be detected. For this purpose the unilateral lobe lesions were concentrated upon, and most often the milder cases, because the more extensive involvements were naturally older and presented no diagnostic difficulties.

It was here observed that in 2 per cent of left lobe lesions, x-ray evidence of inflammatory changes was obtained from two to three days before the physical signs were obvious. To be sure, those patients were sick, and were admitted as uncomplicated influenzas, presenting all the characteristic symptoms of such; and yet they had involvement with no detectable signs until the lesion became quite superficial. That this must have been so was gathered from studying our daily x-ray films, which showed that the pneumonia began at the hilus of the lung.

On the other hand, in 1½ per cent of cases, practically no physical signs at all were ever obtained. At most one could detect harsh breathing, so-called puerile, frequently attributed to toxemia, but no definite râles. These formed an exceedingly interesting group. Serial plates would show an initial film which was negative, subsequently developing pneumonitis very often not exceeding the size of a half dollar, which would disappear within two to four days. Those patients were not unduly sick, and under ordinary circumstances would have been discharged as influenzas without pulmonary involvement.

Another important feature in connection with unilateral lesions is the fact that 2 per cent, who on admission or later presented nothing but a generalized bronchitis, bilateral, with the usual sonorous râles, often showed on a film the characteristic shadow of hemorrhagic pneumonia in the left lower lobe. This alone was not large in extent but was yet presumably sufficiently deep to be masked by the associated bronchitis of the larger tubes, and in ordinary examinations would have been entirely overlooked. In other instances it occurred in more than one lobe.

In other words, small patches of bronchopneumonia demonstrable by x-ray are entirely obscured by the general bronchitis which prevents their detection by the clinician.

(b) *Bilateral Lobe Involvement.*—Many of the unilateral lesions did not stop there. In studying the progressive development of physical signs in connection with the x-ray, it was noted that the spread of pneumonia was readily comparable to the growth of a mushroom in that it always commenced at the hilus, the lesion spreading out from the root as a pivot. Both the left and the right lower lobes might appear to have become involved simultaneously, or the lower portion of the left upper and left lower, or possibly the mesial portions of the right lower, middle and upper, in their contingu-ous vicinity. Thence it was propagated toward the periphery, and on the plate, the involvement looked like an advancing film of smoke. Various combinations prevailed. In analyzing the lobar distribution in the films in 189 cases, the following was observed:

Involvements found	*Clinically*	*X-ray*
Right and left lower lobes only . .	69	42
Lower left lobe only[4]	46	45
Left upper and left lower lobe alone	0	9
Right upper middle and lower . . .	1	3
Left upper and lower, right lower .	1	1
Right middle and lower, left upper and lower	2	2

[4]The reason for this remarkable concidence is that the analysis of 470 cases studied by x-ray showed that in 82% the pulmonitis began in the lower left lobe, and in 14% was confined to that lobe.

Involvements found	*Clinically*	*X-ray*
Right middle and lower, left lower .	4	3
Right middle and lower	4	8
Upper right, lower left[5]	1	1
Right upper, middle and lower . .	1	4
Right lower, left upper and left lower	1	1
All lobes	8	9

(c) *The severe cases* which recovered presented partial involvement of all lobes. There were 5 of those in which the affected areas were small, as may be readily understood, for otherwise when the involvement was extensive the mortality was high. It was an easy matter, both from a clinical and roentgenological study, to make a prognosis based upon the progress of a pneumonia. With the possible exception of one case, the roentgenologist from his point of view made a correct prognosis in every instance by watching the daily spread of the process. Frequently could be seen a recession of involvement one day, which almost always coincided with the clinical condition, and two days later a fresh spread, even over the same area, which was apparently recently subsiding, as corroborated by *x*-ray.

III. Sequellae and Complications

In those patients who recovered from Influenzal Pneumonia the following points were investigated.

1. How long did symptoms and physical signs persist after the *x*-ray became negative?

2. Did *x*-ray findings and clinical symptoms persist after all physical signs had disappeared?

3. Did physical signs and *x*-ray evidence of lung pathology disappear together?

(A) In analyzing 78 hemorrhagic pneumonias who recovered without complications, the following distribution was noted:

(a) Nineteen showed physical signs after the *x*-ray had become negative for pulmonary involvement.

(b) Forty-four presented *x*-ray signs after the physical signs had disappeared.

(c) Fifteen became free from physical and *x*-ray signs about the same time.

The nineteen in whom physical signs were found to persist after the *x*-ray was reported negative for lung lesions, as a rule, were apparently well clinically. They complained perhaps of an occasional slight dyspnea on exertion and moderate cough as you might expect during convalescence. The temperature was down in all. The physical signs which they presented were either the sonorous râles of a generalized bronchitis or a few moist crepitations at one base or both. These were superficial and best heard on deep inspiration. The impression which this created was that the râles were due to atelectasis rather than actual infiltration. As a rule, no dullness was noted. The longest period during which these signs persisted was fifteen days, the shortest, one. No cardiac symptoms were noted.

The forty-four in the second group, who presented no physical signs but in whom there was a residual pneumonia as demonstrated by *x*-ray only, presented the following group of symptoms:

Asthenia was very marked. Loss of weight was pronounced. They coughed readily, occasionally expectorating blood-streaked sputum. Dyspnea prevailed on exertion. They were prone to have an occasional elevation of temperature up to 99° in the afternoon. Not infrequently, tachycardia was present. Convalescence was much prolonged. The longest duration in which *x*-ray findings persisted was twelve days; the shortest, one day.

In the third group, although the fifteen cases observed became free from clinical signs and *x*-ray evidence approximately at the same time, in some of them persistence of both continued three months and longer after the temperature was normal. Up to the present, in cases of this group who are still under observation, physical signs have been found for periods anywhere from three to fourteen weeks. They are usually basic in distribution, affecting most often the left lower lobe, and are characterized by crepitating râles, moist, fine and medium sized,

[5] In this case, the upper right was lobar pneumonia, the lower left, hemorrhagic pneumonitis.

associated with broncho-vesicular breathing. Such cases bear a striking resemblance to the persistent hemolytic streptococcic pneumonias, which we saw frequently last year (1917-18). In those, physical signs remained for four to five months, and frequent search for the tubercle bacillus proved fruitless. When one bears in mind that secondary infection is of such importance in influenzal penumonias, where the pneumococcus and hemolytic streptococci are so frequently found, it is not at all surprising that we may have persistent pneumonia due to these secondary invaders. That such bacteria are not at all unlikely to produce a productive inflammatory lesion where the process goes on for some time, is well known. When frequent examinations of sputum by the mouse inoculation method reveals the presence of these organisms time and again, such assumptions are not at all unfounded. This has been demonstrated in our cases; x-ray in such instances often shows localized involvement, and in addition a high degree of peribronchial fibrosis (peribronchitis) and peribronchial adenitis.

It is not at all surprising that these prolonged influenzal pneumonias should be looked upon with a suspicion of being tuberculous. If they are not tuberculous originally—and as a rule they are not—they present a *locus minoris resistentiae* where the ubiquitous tubercle bacillus may find fruitful soil. For that reason alone, great care should be exercised in the first place in making the diagnosis, and second, against condemning an individual to the category of and association with tuberculous patients on physical signs alone. The important point for differentiation is, as has been repeatedly noted, that the streptococcic and the so-called influenzal pneumonias are essentially *basal* in distribution. Although occasionally lesions due to these organisms have been encountered in the upper lobes, they never involve the true apex. The few of the upper lobe type that we have seen and which have suggested tuberculosis have completely cleared up under observation within three to four months.

(B) Perhaps the most important group of cases which have come to our attention has been that in which the x-ray demonstrated the occurrence of an acute peribronchial infiltration and mediastinal adenitis. Twenty-six cases have been collected because they showed a persistence of adenitis, varied in extent, and because of certain sequellae they presented, which in all probability have a definite bearing upon their subsequent history.

These cases, however, were not the only ones which showed adenitis. Where the pneumonic lesion was not so extensive as to obscure the view, it was noted that the mediastinal glands were more or less affected in most instances. The waxing and waning in size of these could be observed daily, concomitant with the progress and recession of the pneumonic process. Not, infrequently, also, in the unilateral cases were seen a hemorrhagic pneumonitis in one lower lobe and an acute mediastinal adenitis on the side opposite to the pulmonary lesion, as well as on the affected side. In addition, fourteen cases showed an acute root adenitis only, without any pulmonary infiltration. Clinically, those patients either had an acute bronchitis of the larger tubes which was not radiographable, or else absolutely no physical signs that could be detected on routine examination. They were regarded as ordinary influenzas. As we look back now, in the light of our present knowledge, we believe that we must have missed a good many influenza cases in whom, in all probability, an acute adenitis was overlooked because x-rays were not done during the early epidemic days. And the asthenias, the loss of weight and the depression which were seen, but to which no obvious cause could be assigned, were in all likelihood due to absorption of toxins from unresolved glands. The entire picture, in a word, was analogous to an acute tonsilitis with a secondary cervical adenitis, or a simple primary acute adenitis such as appears quite often in children after exanthematous diseases. Later on in the epidemic, when information was received that an acute adenitis obtained,

more careful examination revealed not infrequently increased whispered voice sounds and bronchial type of breathing close to the spine along the upper thoracic vertebra. Apparently D'Espine's sign, useful in the diagnosis of tuberculous adenitis, served equally well in influenza. These findings are not at all strange; they correspond to the natural state of affairs which we see every day in glands draining inflammatory areas in obviously accessible locations. The autopsies of 100 patients showed, in the greater percentage of cases, more or less involvement of these glands. In seventeen cases where cultures were made, the organisms which were recovered from the lungs were identical with those obtained from the glands, thus:

Pneumococcus	9 times
Hemolytic Streptococcus . . .	7 "
Bacillus Friedlander	8 "
Staphylococcus	3 "
Influenza	1 "

It would seem from these that the lymph glands apparently either harbored the organisms which caused the pneumonia or else the organisms invaded the glands secondarily. In this last instance, it would be held that the lung was the source, the infection there having been induced either by direct transmission through the bronchi or by the blood stream. If, on the other hand, the first holds true, namely that the lymph glands were the source, then the small number of positive blood cultures obtained (only 14 out of 200) and the multiplicity of organisms found in lungs, may prove one of its explanations. Here the assumption would be that the organisms were transmitted through the lymphatic system and arrested in the lungs, not enough escaping into the blood stream to produce a septicemia. It is a well-known and widely accepted fact that the tubercle bacillus not infrequently starting in the tonsils passes down the cervical glands, thence through the mediastinal glands, the thoracic duct and right heart, and finally invades the lung through the lesser circulation. Why not the pneumococcus, streptococcus or influenza bacillus?

Sections of lung stained for bacteria in situ have frequently shown pulmonary lymphatics full of organisms. This has recently again been corroborated by MacCallum in his study of streptococcic lesions in influenzal pneumonia. It is evident, therefore, that an inflammatory process must be going on in the lymphatics and mediastinal glands as well as in the lungs where these same organisms are found.

If, on the other hand, the bacteria are secondary invaders of the lymph glands, then the next question which arises is, in case the patient gets well, what becomes of these? Does the inflammatory reaction which the organisms set up in the glands, as evidenced by their hyperemia and increased cellular infiltration, subside altogether with the inflammatory condition of the lung, and the organism absorbed? Our *x*-ray studies have to a certain degree answered this question. We have found in the twenty-six cases under consideration that the root adenitis has remained to a greater or less extent thus far from one week to three months after complete recovery. If, therefore, the adenitis does not completely disappear, are the organisms still harbored in these glands? If so, are they responsible for the recurrent attacks of influenza and its pneumonia—pneumonia irrespective of influenza which is so frequently encountered throughout the year in both civil and military life? Are they the causes of persistent, productive pneumonia, and also perhaps accountable for the readiness with which the tubercle bacillus finds its way in certain instances into this prepared field? Again, are the glands with the many organisms which they contain similar to the tonsils, foci of infection, responsible for some of the acute arthritides and pleural infections which have occurred after the patient had presumably recovered from his pneumonia? Occasionally an afebrile period of a week or more has been seen in pneumococcic empyemas following pneumonia. It is difficult to establish all these points, because of necessity the glands are inaccessible for cultural purposes *intra vitam*. Yet if by subsequent history

and with the aid of the x-ray such things can be followed up, valuable data may be adduced in support of this contention.

As corroborations of this hypothesis a number of type cases have been collected and are hereunto appended.

Acute Influenza with Adenitis Only, Preceded by Pneumonia:

CASE 1.—W. J. H., 30116 and 16139. Patient discharged with diagnosis of bronchopneumonia, right base.

June 13, 1918, Temperature between 99° and 100°; pulse 70 to 90. Sputum, pneumococcus type IV. X-ray on discharge, negative for pulmonary involvement.[6]

Re-admitted Sept. 28, 1918. Diagnosis, acute influenza. Temp. 103.2° on admission, which lasted two days with a critical fall. X-ray on Oct. 9th showing mediastinal glands to be greatly enlarged.[7]

Two Attacks of Pneumonia, February and March

CASE 2. A. T. Admitted Feb. 15, 1919. U. S. A. Hospital No. 1, Hoboken, N. J. Diagnosis on discharge, lobar pneumonia, lower and middle right and lower left. Pneumococcus type II.

History: Began 8 days ago on board S. S. Leviathan en route from France. Acutely ill on admission with fever, cough, pain on respiration, pain in both lungs, crisis Feb. 17. Blood count 2/16 W.B.C. 12,400. Polynuclears 76 S. M. 24.

Feb. 21. Continues to improve.

Feb. 26. Continues well.

March 4. Has some pain in right side, otherwise well. Transferred.

March 7. Admitted to Walter Reed General Hospital. On admission, felt well. Complains only of occasional pain on right side when he takes a deep breath, coughs slightly; no sputum; no other symptoms.

Physical examination absolutely negative on admission.

[6] At that time we did not recognize the significance of mediastinal adenitis.

[7] Hereafter the term acute adenitis will be used.

March 11. G. C. good. No physical signs in lungs. No complaints.

March 14. Patient does not feel well. Went out yesterday, suddenly experienced a pain in right chest, temperature up this A. M. 100.2°, pulse 108, respiration 22. Physical examination reveals patch of crepitating râles at the left base posteriorly. Diagnosis: Bronchopneumonia, left base (J. H.). Blood cultures sterile.

March 15. Patch of crepitating râles at the right angle of the scapula.

March 16. Temperature 99.4°. No change in physical signs. Note by Ward Surgeon. Patient is probably having slight recurrence of old pneumonia. W. B. C. 6,800, negative for T.B.

March 22. General condition good. Temperature 98°. Patient up and about. Chest clearing. W. B. C. 8,250. Throat culture H. S. 3 plus. X-ray examination: Root adenitis, acute. Lungs negative.

Two Attacks of Pneumonia, root adenitis, Acute Arthritis

CASE 3. E. D. W. 19745, 26181. Admitted Sept. 23rd. Diagnosis: Acute Influenza.

Sept. 27. Acute bronchopneumonia, left lower base, chronic mitral regurgitation existed prior to enlistment. Patient very ill. Serious illness slip sent out.

Nov. 14. Improved. Lungs clear.

Nov. 18. Went on furlough for 15 days.

Dec. 6. Returned from furlough. Examination shows a very rapid heart and loud systolic murmur at apex. Transferred to convalescent ward.

Jan. 13. Disability papers prepared and forwarded for action.

Feb. 2. Harsh breathing and signs of consolidation at left base.

Feb. 3. X-ray examination: Early involvement of upper portion of left lower lobe, also distinct involvement of root glands on both sides.

Feb. 6. Râles over the left lower lobe disappearing; temperature 99.8°, pulse 88, respiration 22. X-ray practically clear of pulmonary involvement.

Feb. 7. X-ray report: Except for root adenitis, the chest was practically clear.

Feb. 8. Temp. 100.4°; pulse 84, respiration 22; Chest negative. Patient complained of pains in joints, especially in knees and wrists.

Feb. 9. Chest negative. Temp. of low grade, probably due to joint involvement and adenitis.

Feb. 15. General condition improved. To be discharged from hospital.

LABORATORY EXAMINATION

Sept. 28, 1918. Sputum rusty, muco-purulent, pneumococcus type IV recovered. Blood culture sterile.

Feb. 5, 1919. Sputum shows pneumococcus type II, irregular and hemolytic streptococcus isolated from mouse. Blood culture sterile. Throat and naso-pharynx positive for H.S.

Two Attacks of Pneumonia, Acute Adenitis, Mastoiditis

CASE 4. L. C. Private French Army. 21500. Admitted Oct. 16, 1918. Diagnosis: Influenza, Bronchopneumonia, both bases (Jaundice quite marked).

X-ray, Oct. 25, shows pneumonia involvement at left lower and right lower and part of left upper.

X-ray, Nov. 5, shows chest clear, except for adenitis.

Nov. 10. Recovered, chest negative.

Nov. 11. Pain in left ear. Tenderness over the left mastoid. Left eardrum punctured.

Nov. 13, 1918. Left mastoidectomy. Gas oxygen anesthetic. Mastoid cells filled with pus. Culture positive for H.S. (Pure).

Nov. 15, 1918. Cough, bloody expectoration, dullness and râles over right lower lobe. Diagnosis: Recurrent pneumonia.

Pneumonia, Unresolved, Lasting Four Months with Adenitis and Peribronchial Fibrosis

CASE 5. C. F. 25902. Admitted to Walter Reed General Hospital Feb. 3, 1919.

History: Had meningitis on way to France in September, pneumonia while convalescing. Patient became hoarse during his attack of pneumonia and has been ever since. Diagnosis on admission: Chronic catarrhal laryngitis; sub-acute gingivitis; convalescent from bronchopneumonia of right and left lower lobes.

Feb. 6, 1919. Laryngeal examination, slight swelling of false vocal cords; improving steadily.

Feb. 14, 1919. Medical consultation. Diffuse râles over both lungs, coarse, medium sized, soft, moist. Resonance is diminished over upper lobe, right, anterior and posterior (B.M.R.).

March 10, 1919. G. C. improved. Râles have for the greater part disappeared. Left lower lobe posteriorly still shows many sub-crepitating râles. Probably subsiding bronchopneumonia. There is an increased whispered voice within scapular region down to the seventh dorsal and bronchial breathing, probably due to adenitis (H.F.S.).

April 1, 1919. Râles, sub-crepitating and crepitant still persist at left base. General condition improved. Seven examinations of sputum thus far are negative for tubercle bacillus, both by the ordinary and antiformin method. X-ray examination shows increased density over middle and lower right, evidence of old right-sided pneumonia, considerable fibrosis and adenitis. Sputum examination, mouse inoculation method, shows pneumococcus type IV, H.S. and Micro. Cattharalis.

Influenza Followed by Pneumonia Succeeded by an Arthritis, Streptococcic Sore Throat and Rash Accompanied by an Acute Bronchopneumonia with X-ray findings of Acute Adenitis.

CASE 6. 24716, B. F. K. Admitted Jan. 6, 1919. Diagnosis on admission: Acute influenza; acute bronchopneumonia, both bases.

Jan. 9, 1919. Complains of pain and tenderness in left knee and ankle. Left knee swollen. No signs of pneumonia at either base.

Jan. 10, 1919. Knee and ankle still

swollen. Urticarial rash over left ankle and left lower thigh.

Jan. 19, 1919. Ankle still sore and stiff. Heart normal. Lungs, clear.

Feb. 10, 1919. Pain in right shoulder still present.

Feb. 14, 1919. Heart irritable. Sitting 108, standing 120. Digitalis administered. Blood pressure 135-90.

Feb. 15, 1919. Left tonsil inflamed. Patient complains of sore throat.

Feb. 18, 1919. Scarlatiform rash over entire body; finely papular in character, discrete, at times confluent, especially in folds of the skin. Throat still inflamed, grayish exudate present on left tonsil. Cervical glands enlarged. Temperature still up.

Feb. 21, 1919. General condition improved. Temperature coming down. Rash fading, no desquamation.

Feb. 23, 1919. General condition not so good this A. M. Temperature up again to 102°. Throat looks much better. Necrotic areas clearing up. Examination of chest shows scattered crepitating râles at right base. Rash disappearing. Involvement of left wrist, which is swollen and red and painful. Diagnosis: Acute infectious arthritis, bronchopneumonia at right base.

Feb. 26. Skin desquamating, left shoulder painful.

Feb. 28. Left shoulder, wrist and left third finger swollen.

March 2. General condition good. Temperature down.

March 4. Para-pharyngeal cellulitis present.

March 7. General condition improved. Throat clearing.

March 17. General condition good. Patient weak. Joints cleared up. Throat negative.

March 21. Greatly improved.

March 23. Furlough 15 days.

LABORATORY EXAMINATIONS:

Urine negative throughout. Blood count 3-17-19, W.B.C. 16,430; 3-17-19, Blood culture sterile, W.B.C. 13,200; 3-22-19, Blood culture sterile, W.B.C. 20,700; Throat culture H.S. 2 Plus.

April 19, 1919. Chest *x*-ray marked adenitis on right side, especially.

Pneumonia Associated with Hemolytic Streptococcus Infection

In going over our *x*-ray films in the later days of the epidemic, we found in certain films a gradual replacement of the smoky appearance which we had learned to recognize as being due to hemorrhagic extravasation in the lung, by progressive discrete mottling. This mottling was observed to occur whenever an interstitial type of pneumonia was present at autopsy. In this group, three cases which demonstrated such a condition were associated with a hemolytic streptococcus infection. The question, therefore, arose whether it were possible that such an appearance could be associated with pneumonias due to certain particular organisms alone, or was it a question of organism associated with the response that the lung makes to infection dependent upon the individual's resistance.

Clinically in these cases nothing new is found in physical signs. By this means it is impossible to differentiate pneumonia associated with a hemolytic streptococcus infection from a hemorrhagic pneumonia with a pneumococcus complicating the situation. Moreover, during this epidemic it was not at all infrequent to find at post the so-called hemorrhagic pneumonitis in one lobe and an interstitial type of bronchopneumonia in another. Consequently, it was hazardous to make a clinical diagnosis of the type of pneumonia that one might expect pathologically. The sputum corroboration was insufficient, because too many organisms were found. The *x*-ray here, therefore, was of supportive value. Of course with the positive blood culture for hemolytic streptococcus, a probable diagnosis of that type of pneumonia was indicated. In one particular case, however, where this obtained, autopsy revealed a hemorrhagic pneumonia of the left lobe and an interstitial on the right, both demonstrable by the *x*-ray.

Turning now to the various complications, such as fluid in the chest, pericarditis, mediastinal empyema, etc., we find here too that our serial *x*-ray studies were of great interest. Occasionally, because of the great quantity of blood in the lungs, physical signs were equivocal. While dullness and bronchial breathing were present, they were nevertheless distant and somewhat suggestive of fluid. This, probably because of the nature of the consolidation, outside of exploratory puncture, was frequently diagnosed by the *x*-ray from the obscuration of the costophrenic angle which in ordinary hemorrhagic pneumonitis was strikingly free from involvement. This freedom also was seen in the apex of the lung and was invariably demonstrated in the plates, repeatedly corroborated by autopsies which showed areas of emphysema along the anterior borders, extreme base and true apices of the lung. The impression one got was that just before the bloody exudate had reached the peripheral portions of the lung, the patient died, and respiration was in the end carried on by the emphysematous lappets of the lung. Hypostasis presumably played a small part, if any. It seemed as if the interplay of vasomotor paresis, extensive hemorrhage, where the patient drowned in his own blood, and toxemia, were largely responsible for rapidity of death.

IV. Bacteriology and Pathology

The bacteriology was done largely under the direction of Colonel Nichols. Our experience has been similar to that of other camps and hospitals. The multiplicity of organisms found has caused us to shift our opinion as to whether the essential underlying etiology is to be attributed to the bacillus of Pheiffer. That this organism has been repeatedly recovered, under normal conditions, is well known. That it has been more often found in this epidemic, associated with pneumonia, has been attested to by certain workers and denied by others. Pritchett and Stillman, as well as many others, apparently adhere to the view that the influenza organism is the cause; on the other hand, equally competent investigators, among them Kinsella,* working in this hospital, seem inclined to the opinion that influenza is caused by an unknown agent. Possibly a symbiosis of the influenza and pneumococcus may be responsible for the frightful mortality. This combination has been reported by many camps. In spite of varying bacteriology, no question has arisen as to the specificity of this disease. The profound depression of the nervous system, the tendency to hemorrhage, the lack of resistance as expressed by the constant leukopenia, the slow pulse, and the characteristic pneumonia, aside from modifications due to secondary organisms, form the basis of this belief.

In reporting the bacteriology, it will, to our mind, be simply a record of the prevailing organisms at this hospital during the the period covered. The pneumonia pictures would be a consequent expression of these; the complications likewise peculiar to the pathogenicity of such organisms.

In the survey of the pathology, 90 autopsies have been collected. Most of these have been preformed by Captain Loyn, to whom we are indebted for permission to study the material. The gross pathology only of 60 cases has been reported on by him. The microscopic appearances of these 60, as well as the gross and microscopic pathology of the remaining 30 cases, which make up this contribution, form important groups for comparison. In comparing them, two factors which may explain the variations observed come to the fore; (a) The duration of life, dependent upon the resistance of the individual, after the onset of pneumonia; (b) The role of secondary invaders. This last was modified primarily by the virulence and consequent predominance of the original infecting agent, and secondarily, by diminution in virulence of the latter, with consequent accession of strength by the secondary invader, varying with seasonal and climatic changes.

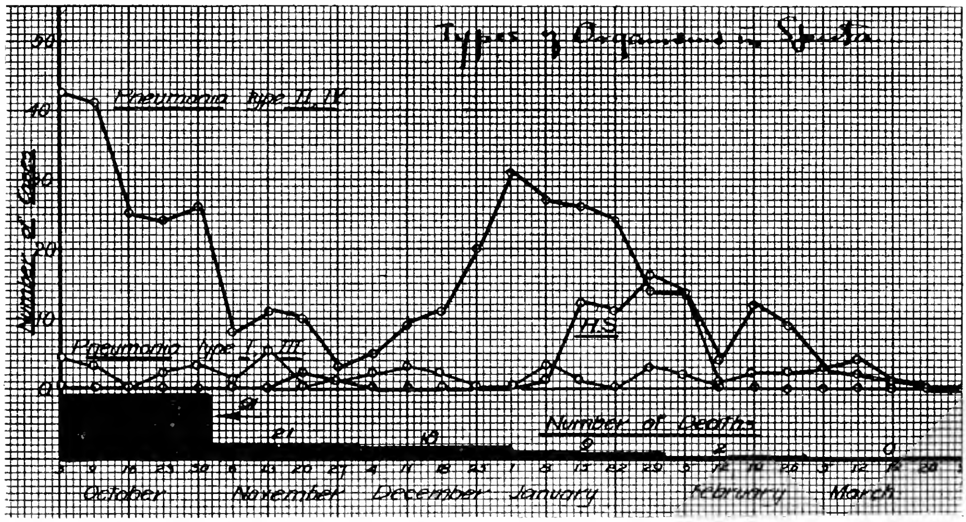
In looking over the histories, it is found that during the months of September and

October, 1918, death took place on an average within eight days after the onset of the disease. From the last part of October through January, February, and March, 1919, the duration of life was between ten and twelve days, even up to twenty or more (one case lasted 165 days). This prolongation of life naturally had a decided bearing on the stages of the lesions.

The key to the second factor is to be found in the study of our chart, recording the sputum examinations from month to month, as well as the cultures obtained from the blood and lungs.

possible general low virulence of the organism in our vicinity supplanted by the greater pathogenicity of the pneumococcus; (b) by the mild weather which prevailed in this locality; (c) by the low resistance of the individual, which brought about his death before the interstitial types of pneumonia occurred.

Turning to the lung cultures of 70 cases, it is again found, parallel with the sputum findings, that the pneumococcus was most prevalent. That organism was recorded thirty-five times, the hemolytic streptococcus twenty-one times, the staphylococcus twenty-three



[This chart is published through the courtesy of Major Simmons, Chief of the Laboratory.]

From the chart it is evident that during October and early November, pneumococci types, II and IV predominated. The mortality during these months was greatest. Then there is a drop until late December, which is again followed by a secondary rise, corresponding to a recurrent wave of influenza during January and February. Here again the pneumococci II and IV are seen in the ascendency, closely followed by the hemolytic streptococcus. In spite of the latter, not many of the pneumonias as such, could be attributed to that organism essentially. The so-called interstitial types produced by the hemolytic streptococcus were indeed few. This may be accounted for: (a) By the

times, the bacillus Friedlander twenty-six times, the influenza eight times.

Blood cultures on 200 cases gave the following results:

Pneumococcus Type II	7 times,	mortality	100%
" " I	4	"	"	50%
" " III	1	"	"	100%
Hemolytic Strep	1	"	"	100%
Staphylococcus	1	"	"	100%

It is obvious from the small number of positive blood cultures, (although several hundred were taken) that when organisms were recovered from the blood, all barriers were shattered. Their numbers must have been overwhelming.

The combination of pneumococcus, the

hemolytic streptococcus or the staphylococcus in blood cultures, plus the underlying infection, was inevitably fatal. The pneumococcus I was true to the type in its low mortality, in spite of influenza.

Correlating the sputum examinations, the lung bacteriology, and the lung pathology, one arrives at the obvious conclusion that the lungs must have been modified by the presence of pneumococcus as the chief invader, the streptococcus, staphylococcus and Friedlander bacillis as minor. Each one of them, in all probability, stamped its own peculiar pathology on this disease to a greater or less extent. Bearing in mind the pictures, as far as we know them, of pneumonia types which these produce when they are solitary otiologic factors, it has been endeavored to classify the pulmonary lesions accordingly, as far as possible.

PNEUMOCOCCUS TYPES, PLUS INFLUENZA

Pathology.—The general postmortem appearance of the patient who died after an illness of short duration was striking. A marked, blotchy cyanosis prevailed. This was especially evident upon the face, neck, ears and dependent portions of the body. Rigor mortis was present in some, absent in others. From the nostrils and mouth of most of them a reddish froth exuded. At times it was merely a clear brownish thin fluid, varying in amount; at others, it literally poured out, on changing the body's posture. In those in whom jaundice was present, the skin and conjunctivae were a peculiar mixture of yellow and blue. Petechiae were occasionally observed on the neck and part of the chest.

On opening the thorax, the pleural cavity presented characteristic features. There were to be found, in 95 per cent of the cases, fluid in varying amounts. In the early autopsies, it looked like a bloody transudate. It was thin in consistency, pinkish or chocolate brown in color; frequently containing fine flakes of fibrin. Anywhere from 20 to 1500 c.c. were obtained. As a rule, it was most abundant on the side of greatest involvement; more often on the left than on the right. As the epidemic wore on and the influenza became less virulent, secondary invaders were in the ascendency; the character of infection began to change; the fluid become more often purulent. It varied from a slight turbidity to a greenish yellow, creamy, pus. In some of the cases, there was simply a thick, shaggy, greenish, fibrinous layer plastering the pleural cavity, the manubrium of the sternum, and the surfaces of the lung. Occasionally, also, were seen pockets of pus situated between the lobes undergoing encapsulation. In such cases, the pneumococcus was recovered. Where the pus was more fluid, the hemolytic streptococcus was more frequently found, less often the pneumococci.

On removal of the exudate, whether it was bloody or purulent, the constant characteristic findings were hemorrhagic spots, varying both as to shape and size. Some were pin point, others anywhere from one to ten mm. in diameter. Occasionally a fusion of these seemed to occur, and a large hemorrhagic area resulted. These were scattered over the parietal pleura, which was also frequently very hyperemic, sub-pleurally, over the diaphragmatic surface of the lung, between the lobes, and especially over the lower parts of the lobes posteriorly. Not only were they confined to these structures, however, but they were also seen to occur over the parietal surface of the pericardium, more often on the left than on the right side, and at times even over the cardiac muscle itself. Microscopically, these appeared as tortuous, distended capillaries, some of which had ruptured, with consequent exudation of blood cells into the surrounding tissues.

Lungs.—The lungs themselves were very much alike in the early cases. Voluminous, irregularly purplish blue, blood-logged. They pitted on pressure like an edema. The veins, blue black, distended, delineated the lobules. Except for the extreme apex and anterior borders, which were emphysematous, the lungs on the whole were firm. The lower lobes, and posterior portions, were more often involved than the upper, the unaffected parts usually displayed a grayish pink color.

The slaty, purplish areas, on the external surface of the involved lung, had a shotty feel in contradistinction to the light-colored areas, which were soft. On section, large quantities of blackish blood dripped. Scraping the incised surface, which was always moist, a mottled appearance was observed. There were places finely spongy in character, reddish brown, meaty-looking, dark red, slightly raised areas interpolated between lighter gray. These varied in size and shape as well as distribution. Most often in the lower lobes, they could also be seen in any and every part of the lung. Where the process had apparently progressed, lobular areas of consolidation, grayish red, were more often found towards the root than the periphery, which on squeezing, yielded droplets of pus. It seemed as if the lesion here were older. Intervening between the solidified areas were also emphysematous lobules, and atelectasis was noted occasionally. In some lungs, however, the bloody infiltration took almost a lobar distribution; in others, the familiar gray hepatization was observed. Even then a mottled appearance prevailed.

The cut bronchi were often surrounded by the more darkly congested areas. In the early cases, they exuded a brownish bloody fluid, mixed with froth, uniformly thin. In some this was increased in consistency, and in later lungs it varied from a thin pus to a heavier exudate.

The bronchial mucosa, as well as that of the trachea, was thickened, soft, velvety, and intensely red, in the majority of instances. One case presented a diphtheroid pharyngitis.

Peribronchial glands were, in 75 per cent of the cases, swollen, soft, socculent. Their color varied from a reddish brown to black, due in part to anthracosis. The increase in size also differed from slight enlargement to about 50 to 60 mm. in diameter. Some were so edematous that on section the gland substance was almost diffluent.

Microscopic.—The early lungs, in which the pneumococcus prevailed as the chief secondary invader, presented the following:

A. In the first place, no uniformity was observed. All stages of involvement could be seen in the sections. The striking feature throughout, especially in the short lived cases, was paucity of cellular exudate on the whole, and the polynuclears in particular. The relative predominance of mononuclear cells was most notable. It seemed as if the general leukopenia which was so characteristic of the disease, was likewise reflected in the inflammatory exudate, and was part and parcel of the entire pathology. On study of the sections, the alveoli, in some portions, were markedly dilated, and outlined by intensely engourged capillaries. They were filled with mononuclear cells, desquamated alveolar epithelium and red blood cells. The inter-alveolar septa in some places were edematous, and filled with a similar exudate. In certain areas a fine coagulum distended the alveoli; in others, shadows of red cells only remained; especially at the periphery of involved lung. Enmeshing the mobilized cells, was a fine fibrin network, which reached out from air cell to air cell. In places, this was obscured by an inordinate outpouring of red corpuscles from ruptured capillaries which covered everything, confluent lobular, in distribution. Inter-alveolar septa, the ductuli alveolaris, and small bronchioles were practically obliterated. The bronchioles were often filled with blood. Their epithelium in many places was intact, in some areas necrosed. A peribronchial infiltration of leucocytes was frequently seen ,gradually shading off into surrounding fields, jammed with well-preserved red corpuscles. The blood vessels were likewise engourged. Clumps of pneumococci filled the alveoli, distributed in the exudate. In some sections, especially where the patient had lived longer, there was a tendency of the exudate to change, although the essential hemorrhagic features prevailed. The bronchi were apt to be filled with many polynuclears, interspersed with mononuclears, and endothelial leucocytes, as well as red cells. Here also were seen many large cells, mononuclears, filled with brownish colored pigment, not anthrocotic, but similar to the "Herzfehler Zellen" of Wagner. Interven-

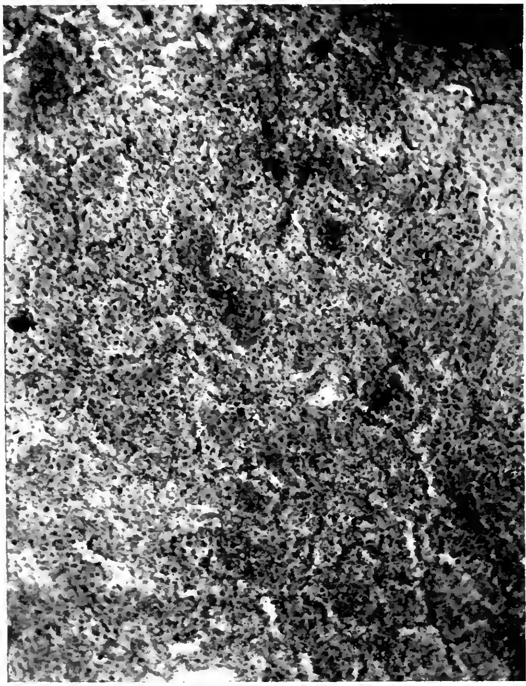
ing between involved lobules were emphysematous spaces. As the process went on, typical gray hepatization could be served.

B. Where the streptococcus had been recovered, as in cases 104a, 117a, 165a, 173a. there was a tendency towards an interstitial broncho pneumonia, plus, of course, the so-called influenza type. This condition has already been emphasized by MacCallum. In our gross sections were noted areas of interstitial inflammation varying with emphysema. One of these cases which lasted 5½ months had in addition multiple bronchieotatic cavities. Micrascopically the branchial walls were invaded with leucocytes largely mononuclear, red blood cells, and desquamated epithelium. Their mucosa was torn away or destroyed in most places. A peribronchial infiltration was invariably seen. The inter-alveolar septa edematous were also infiltrated with mononuclears and red cells. No marked increase of fibrous tissue was noted. Accompanying these appearances were likewise areas of lobular pneumonia where everything was obscured by a tremendous exudate.

We had four cases where the staphylococcus predominated; one of these had a positive blood culture (180a.).

Grossly, the fundamental characteristic of the influenzal lung, viz., hemorrhagic pneumonitis, the petechial spots over the visceral pleura and lung surfaces, were invariably present. In addition (in 180A) were noted bosses of fibrin 5 to 10 mm. in thickness, covering the purplish colored lung. Cut section revealed the familiar dark reddish brown areas, intermingled with irregular grayish pink areas of consolidation, varying from 5 to 10 mm. Immediately beneath the pleura small abcesses, 5 to 10 mm. in diameter, were evident, others were more deeply situated.

Microscopically all the features of the lungs above described were present. In addition, gradations were seen from areas where polynuclear exudate covered everything, obliterating the alveolar cavities in one

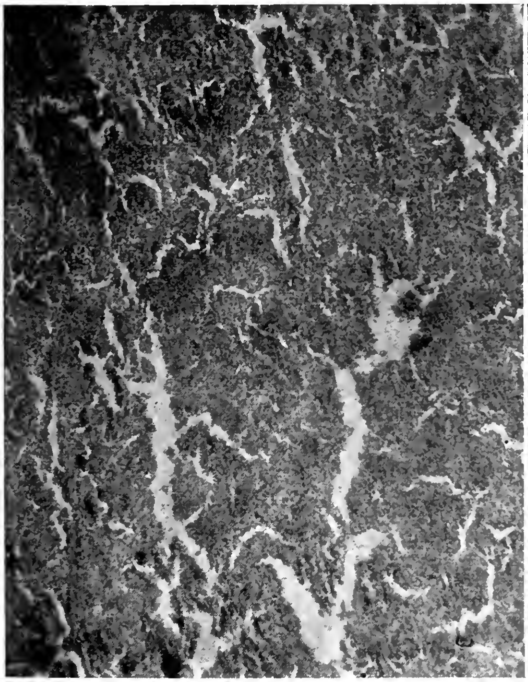


Influenzal Pneumonia with Abcess Formation Due to Secondary Staphylococcus Infection (180a).

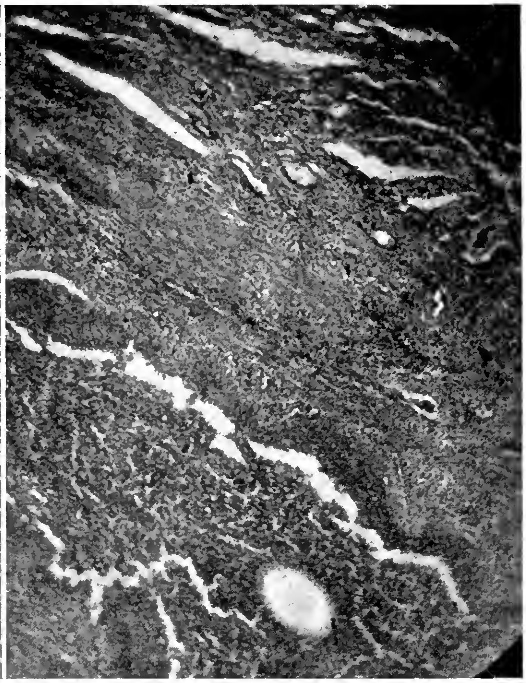
Hemorrhagic Pneumonitis with Mononuclear Exudate.

necrotic mass, to fields just covered with blood. Scattered through them were abcesses of various sizes. No attempt at limitation of these by new connective tissue was observed. In some of such collections of leucocytes, degenerated cells and destroyed lung tissue, numerous mononuclears likewise prevailed.

We observed no cases in which the influenza was the only organism recovered. The bewildering complexity of the bacteria made it indeed difficult at times to attempt a classification of the pathology observed. It was obviously perplexing to say absolutely that this or that organism was chiefly responsible for the condition, when two, or even three bacteria operated in the same lung. Although, as it is shown, the Friedlander bacillus was often found, no characteristic lesions such as have been described as pertinent to this organism were ever seen. This bacillus was undoubtedly one of the pre-agonal invaders, and has already been reported on by Nichols and Stimmell.



Hemorrhagic Pneumonitis.



Interstitial Broncho-pneumonia with Bronchiactasis (173a).

OTHER PATHOLOGICAL CONDITIONS

The pericardium, in 80 per cent of the cases, showed the presence of fluid. The character varied from a clear serous yellow to a hemorrhagic type. It was bile-tinged, whenever jaundice obtained. Later in the epidemic alternating grades of turbidity, even to a marked purulent exudate, were seen, in a small percentage of cases. The quantity differed anywhere from 2 c.c. or merely a yellow frosting, interspersed with numerous petechiae, associated with dependent thin pus in the bottom of the sac, to an exudate of 400 c.c. In two cases the typical bread and butter appearance was observed. In the majority of instances, purulent pericarditis was associated either with a pneumococcus or streptococcus infection.

Heart.—On the whole, the heart showed very little involvement. In 76 cases, 14 presented moderate dilatation on the right side, one on the left, two, slight hypertrophy of the left. Mitral disease was found in two

cases. This, however, did not seem of recent origin. The cardiac muscle, as a rule, showed no degenerative changes. Occasionally was seen some athero-sclerosis at the base of the aorta.

The spleen was usually somewhat involved. In the majority of instances, it was soft and flabby, covered at times by very dark red blotches.

The stomach, in most instances, was hyperemic. The fundus, the seat of numerous petechial spots. The duodenum was very often markedly congested. Similar conditions were seen to a varying extent in the rest of the alimentary tract.

The liver was at times enlarged, pale reddish-brown, with irregular yellow mottling, due to moderate fatty changes.

Microscopically, there were present granular degeneration, for the most part, and slight fatty degeneration.

The kidneys were congested and showed cloudy swelling. In sections, granular degeneration and engorgement of the vessels were observed.

The brain presented edema, congestion, and some flattening of the cerebral convolution. Lepto-meningitis was observed in two cases. From one the pneumococcus and staphylococcus were recovered.

The cephalic sinuses were examined in seventeen cases. This was done with the co-operation of the Otological Service. The technique employed was as follows:

After the removal of the brain, the interior of the skull was stripped of dura, and washed with alcohol. The face and reflected scalp was then covered with a towel and the alcohol in the cavity ignited. The sinuses were then opened singly with sterile instruments, and cultures made from the mucous surfaces. In none of these cases, with one exception, were there enough ear or sinus symptoms requiring attention intra vitam. The sinus most involved was the sphenoid. In many there was present a small amount of dark, muco-purulent fluid. The mucous membranes were reddened. In others, yellow muco-purulent fluid was recovered. The presence of this may have added a good deal to the toxemia and cerebral depression. From the point of view of frequency and organisms recovered, the sinus involvements presented the following:

INFLUENZA POST-MORTEM ON SINUSES IN 17 CASES.

	Sphenoid		*Post. Eth.*		*Ant. Eth.*		*Frontal*		*Maxillary*	
	Right.	*Left.*	*Right.*	*Left.*	*Right.*	*Left.*	*Right.*	*Left.*	*Right.*	*Left.*
No. Showing pathological changes	14	13	11	9	5	7	4	5	5	3
Influenza Bac.	1									
H. S.	2	2	2	1		1			3	2
Pneumococcus	6	5	5	4	3	2	2	1	2	1
Friedlander Bac.	4	1	2							1
Staphylococcus albus.	7	3	5	4	3	4	1	1	5	
Pyocyaneus	3	2	1	1		2			1	
Micrococcus catarrhalis		2	1	1	1					
Contaminations......	2	1								
No Report...........	1									

For the purpose of comparing the bacteriology recovered from normal, uninvolved sinuses, a number of cases were cultured with the following results:

	Sphenoid		*Post. Eth.*		*Ant. Eth.*		*Frontal*		*Maxillary*	
	Right.	*Left.*	*Right.*	*Left.*	*Right.*	*Left.*	*Right.*	*Left.*	*Right.*	*Left.*
No. showing no pathology	3	4	6	8	12	10	13	12	11	13
not opened									1	1
Influenza Bac.						1				
H. S.		1	1	1	3	1			1	3
Pneumococcus	1	3	1	2	6	3	1	1	1	3
Friedlander	1	2	1	1	3	3	3	2	3	2
Staphylococcus albus.	1	1	2	3	5	3	2	3	8	8
Pyocyaneus				1	3	1	1	1	1	2
Micrococcus catarrhalis					1	1				
No growth	2		2	2	2	2	7	7	1	
Contamination						1	1			
No report		1	1	1	1	1	1		1	
No specimen									2	2

Summarizing, we find the following organisms:

Staphylococcus albus	65
Pneumococcus	53
Friedlander bacillus	36
Hemolytic streptococcus	24
Pyocyaneus	20
Influenza	8
Micrococcus catarrhalis	6
Contaminations	5
No report	1

An analysis of all these findings makes it obvious that almost all the bacteria which were identified in one way or another, as secondary invaders in influenza, were quiescent inhabitants of the skull, ready to run riot at the least provocation. The question, what are the underlying factors that cause one or another of these organisms to assume pathogenic properties, is still awaiting an answer.

BIBLIOGRAPHY

MAC CALLUM, W. G. Pathologie of Pneumonia following Influenza. *J. Am. M. Assn.,* March 8, 1919, p. 720.

KINSELLA, R. A. Bacteriology of Epidemic Influenza Pneumonia. *J. Am. M. Assn.,* March 8, 1919.

PRITCHETT, I. W. and STILLMAN, E. G. Occurrence of Bac-influenza in Throats and Saliva. *J. Exper. M.,* March, 1919, Vol. 29, p. 256.

NICHOLS, H. J. and STIMMEL. Pneumobacilli as Complicating Organisms in Influenzal Pneumonia. *J. Am. M. Assn.,* Jan. 18, 1919, Vol. 72, p. 174.

THE AMERICAN JOURNAL OF ROENTGENOLOGY

PUBLISHED BY PAUL B. HOEBER, NEW YORK CITY

Issued Monthly. Subscription, $6.00 per year. Advertising rates submitted on application. Editorial office, 480 Park Av., New York. Office of publication, 67-69 East 59th St., New York.

TWENTY-FIRST ANNUAL MEETING

The Twenty-first Annual Meeting of The American Roentgen Ray Society will be held at Rochester, Minn., and Minneapolis, Minn., September 15. 16, 17 and 18, 1920; at Rochester on the 15th, at Minneapolis on the 16th, 17th and 18th.

Further details and advance information concerning the meeting will appear in these columns from month to month.

Minneapolis headquarters, Hotel Radisson.

MEETING OF EASTERN SECTION AMERICAN ROENTGEN RAY SOCIETY

At the last meeting of The American Roentgen Ray Society provisions were made for the establishing of various sections in different parts of the country. The Eastern Division includes that part east of the States of Ohio, Kentucky, Tennessee and Mississippi. For several years there has been held an annual Eastern Midwinter Meeting at Atlantic City. The section just organized will replace those meetings.

The first annual meeting of the Eastern Section of the American Roentgen Ray Society was held at Atlantic City, Jan. 30 and 31, 1920. This meeting was very largely attended. Papers were read as follows:

Roentgen Ray Economics, Dr. Byron C. Darling. Tumor of a Phalanx, Dr. Howard Ashbury. The Diagnosis and Localization of Non-opaque Foreign Bodies in the Bronchi; Clinical, Bronchoscopic and Roentgenological Observations, Dr. Chevalier Jackson, Dr. Wm. H. Spencer and Dr. W. F. Manges. An Unsuspected Foreign Body in the Bronchus, presenting some unusual features, Dr. David R. Bowen, and Dr. Willis F. Manges. Some Extensive Non-tuberculous Chest Cases, Dr. James T. Case. Observations on Diagnosis of Lung Conditions after Influenza Relative to Tuberculosis, Dr. Isaac Gerber. Roentgen Ray Study of Increased Cardiac Dullness, Dr. Charles L. Martin. Further Observations of Pneumo-peritoneum, Dr. Wm. H. Stewart. Experimental Study of the Duration of Artificial Pneumoperitoneum, Dr. L. T. LeWald. Radium and Roentgen Ray Therapy of Carcinoma of the Cervix and Uterus, Dr. R. H. Boggs and Dr. Charles H. Viol. Roentgen Therapy of Carcinoma Within the Abdomen, Dr. George E. Phaler. Treatment of Thymus

Gland Enlargement in Infants, with Radium, Dr. A. C. Heublein.

Dr. W. D. Coolidge discussed the operation of tubes above voltages of 100,000, and reviewed the foreign literature upon this subject. Dr. A. Howard Pirie described a new instrument for localizing foreign bodies in the eye. Dr. Quimby described a method of agitating the developer in stone devoloping tanks.

Lantern slide demonstrations were given on the evenings of the 30th and 31st.

The constitution and by-laws as provided for by the American Roentgen Ray Society at its last meeting at Saratoga were adopted.

The following officers were elected:

President
Dr. David R. Bowen, Philadelphia, Pa.
Vice-President
Dr. H. M. Imboden, New York City
Secretary-Treasurer
Dr. J. M. Steiner, New York City

DEATH OF DR. F. JAUGEAS

It was with great sorrow that American *x*-ray workers received the sad news of the electrocution of the well known French radiologist, Dr. F. Jaugeas, who met his death while conducting an ordinary fluoroscopic examination of a patient. Dr. Jaugeas was making a screen examination at the little American hospital at Neuilly on the outskirts of Paris. The equipment consisted of a small high-tension transformer built after the model of the bedside instrument used by the American Army in France. From Dr. A. Béclère the writer learns that this small transformer was being worked from alternating current without a rotating rectifier and with a radiator type Coolidge Tube. The *x*-ray room was very small and one of the high tension wires from the transformer to the tube had been allowed to sag lower and lower until in the course of a fluoroscopic examination, while Dr. Jaugeas had his hand upon the metal knob intended for controlling the movements of the tube, contact was established between the high-tension wire and the tube stand, which was not earthed, causing a direct short circuit from the main feed wire through the transformer to our unfortunate friend, who fell with his hand still grasping the tube holder which he pulled down with him. The floor was of concrete, which did not improve the situation. The room was in darkness at the time and the only one present besides Jaugeas and the patient was a surgical colleague of Dr. Jaugeas, who did not understand the working of the apparatus and was unable to turn off the primary current immediately. The instrument in use was not an American instrument; but one built on the type of the American trans-

Dr. F. Jaugeas.

former, as above mentioned, in which the secondary high tension wires are in direct connection through the transformer with the primary current. With apparatus of this kind it is important that all the apparatus should be earthed.

The tragic death of Jaugeas is an international loss; born in 1880, son of a village school-teacher, he acquired in his home the love of work and study which always animated him. Greatly beloved among his French confrères, his loss was especially felt

by his chief, that dean of radiologists, Dr. A. Béclère. He was first trained in physics and pharmacy, and in 1903 was appointed pharmaceutical interne of the Hospitals of Paris. Here he entered the service of the Hôpital St. Antoine, where he served under Dr. Béclère. Jaugeas' duties as pharmaceutical interne brought him in charge of the *x*-ray laboratory of this hospital under Dr. Béclère, where he at once became enthusiastic over this new science; and during the seventeen years in which he continued this work, except when absent in his war service, he continued as the associate of his beloved teacher, Béclère. His study in medicine began shortly after, and Jaugeas was successively named pharmaceutical interne, externe of the hospitals, and after receiving his degree in medicine, assistant in radiotherapy.

In a recent issue of the *Journal de Radiologie et d'Electrologie,* Dr. Béclère bears touching testimony to the "most fortunate gifts of intelligence, the lively and energetic spirit and the untiring love of work, the most beautiful and attractive moral qualities of Jaugeas."

Our deceased friend's scientific achievements include, among others, a translation of Grashey's "Atlas of Normal Radiography" in 1909. He successfully competed for one of the prizes awarded by the Academy of Medicine and obtained the title of Laureate of this society, his inaugural thesis bearing the title, "Roentgen Ray Diagnosis and Treatment of Hypophyseal Tumors, Gigantism and Acromegaly." This work proved to be fundamental, and it still marks an important advance in the evolution of medical radiology. Dr. Jaugeas was one of the founders and enthusiastic supporters of the Société de Radiologie Médicale de Paris, now known as the Société de Radiologie de France. Later he became a founder of the *Journal de Radiologie et d'Electrologie.* His principal work, a text book on radio-diagnosis (Précis de radiodiagnostic) was a model of simplicity, which at once filled a real need and has come to occupy an important place in the library of radiologists the world over. We most heartily agree with Béclère in acclaiming the deceased as a finished clinician, a learned physician and expert, accomplished in the new specialty, accounted both at home and abroad among the great masters of French radiology.

During the war, Jaugeas served first in the hospital at Marseilles, then at Mans, later with the armies of the field before Verdun, and still later as director general of the radiological service of the French Army in Northern Africa. While serving before Verdun in the hospital at Vadelaincourt he miraculously escaped death during the bombardment of his hospital by German aviators.

We assure our French colleagues, and particularly the family of the deceased, who was personally known to a number of American radiologists who served in France, that we sincerely share the sorrow of their bereavement.

James T. Case, M.D.

DANGERS IN THE X-RAY ROOM

The death of Dr. F. Jaugeas, referred to elsewhere in this issue of the Journal, led to the publication by Messrs. Watson & Sons of a leaflet entitled "Dangers in the *X*-ray Room," setting out clearly the precautions necessary to insure the safety of operators. This leaflet was recently published in the *Archives of Radiology and Electrotherapy,* and we take the liberty of copying it here.

1. All metal parts of the outfit, such as the switch table, couch, screening stand, tube stand, and particularly the tube box, and handles controlling the movements and diaphragm, should be efficiently earthed. For this purpose a flexible cable is preferable to a rigid wire, which may break or become disconnected. The earth wire should be connected to a water supply pipe, a drain pipe or an earthing plate. Wooden floors are safer than concrete for the operator. Concrete should be covered with some suitable material, such as wood or thick linoleum. Rubber-soled shoes may prevent a nasty accident.

2. When operating x-ray tubes there should be no slack wires; all connections should be taught and kept so by a spring.

3. Whenever possible use heavily insulated wires, but even these should always be treated with the same precaution as a bare wire, as the insulation deteriorates in the course of time.

4. All connecting wires and high tension apparatus must be out of easy reach or guarded so that assistants or patients cannot inadvertently touch them.

5. It is most important that overhead wires should be examined from time to time, and precaution should be taken so that a live wire cannot fall on the patient or operator. With this end in view, it is a good plan to place across the x-ray room several bare wires connected to earth and at right angles and below the high tension overhead wires, so that should one of these break it is brought into contact with an earthed wire.

6. Periodically examine all wires leading from the high tension apparatus to the overhead high tension cables, and if necessary duplicate the method of fixing.

7. Great care should be taken that all fuses carry only the maximum current required by the apparatus, so that any overload or earth leakage will immediately blow the fuse.

8. When using the Coolidge Tube installation, where the metal extremities of the tube may be close to the patient, it is desirable to provide a cover of metallic gauze, which is connected to earth, so that an involuntary movement may not cause the patient to receive a spark. All metal applicators should also be earthed. Sand-bags will be found useful for checking the involuntary movement of patients.

9. In those x-ray rooms which are without a water supply, a special earth plate should be fixed in the ground and an earth wire run round the room so that several earth connections can be easily made.

10. Avoid an arrangement which allows of two pieces of apparatus being simultaneously connected to one high tension source.

11. Never touch the high tension trolley rods without first shutting off the current.

12. Do not install the apparatus in a room so small that it becomes dangerous to move about.

13. Always have a colleague or assistant, if possible, who is familiar with the position of the main switch.

14. When examining and testing an installation do not be satisfied with merely shutting off the main switch on the apparatus, but also switch off at the main supply.

Apart from the above suggestions great care must be exercised in working, because it is impossible to foresee every contingency, and accidents may occur which are not provided for in the above notes.

The *Archives* adds the reminder that the above precautions refer only to high tension currents, and that, in addition, there is constant danger from primary and secondary radiations unless there is adequate protection. The occupants of a room above or below the x-ray room may be unwittingly subjected to radiation unless proper steps are taken. The x-ray tube should be completely surrounded by lead sheet, not less than 2 mm. thick (preferably more), leaving only the smallest necessary aperture for the beam of rays utilized to emerge.

The need for thorough protection from high- and low-tension currents is very great, and all who are responsible for the safety of workers in x-ray and electrical departments will feel with us that the time has come when thorough inspection by electrical experts is essential in all of those departments. Some Federal authority should take the matter up and appoint an expert, who should visit all x-ray and electrical departments in hospitals and private institutions, with a view to assuring that the work be carried on under conditions of absolute safety.

NOTICE TO WESTERN ROENTGENOLOGISTS

The summer meeting of the Pacific Coast Roentgen Ray Society will be held at the Catalina Islands, June 17 to 20, 1920.

TRANSLATIONS & ABSTRACTS

STEWART, GEORGE DAVID, and BARBER, WILLIAM HOWARD, New York. The Gastric Hypermotility Associated with Gall-Bladder Disease. (*J. Am. M. Assn.* Vol. 73, No. 24.)

The authors begin with the statement that the stomach is the recognized spokesman for any abdominal condition but more especially for the gall-bladder, duodenum and the appendix. They remark on the difficulty in localizing the disease in any one of the three, and also of excluding the stomach even when a definite diagnosis in any of the above can be made.

They mention two ways of studying the question; the review of recent hospital records and the experimental laboratory from 1911 to the present time. The only cases selected are those that have a complete roentgenographic report based on complete gastrointestinal examination, and confirmed or modified by direct inspection of the open abdomen. The percentages as as follows:Disease of the gall bladder (meaning with or without stone): Hypermotility 68.4 per cent, Hypomotility 0 per cent, Normal 31.6 per cent. Diseases of the duodenum: Hypermotility 55 per cent, Hypomotility 12.5 per cent, Normal 12.5 per cent. Chronic Appendicitis: Hypermotility 55 per cent, Hypomotility 0 per cent, Normal 45 per cent. For comparison a series of experiments of animals gave the following results: Gall bladder stimulation (direct irritation): Hypermotility 61.5 per cent, Hypomotility 0 per cent, Normal 15.4 per cent, Retrostalsis 23.1 per cent. Duodenum (Direct trauma), Hypermotility, 66.7 per cent, Hypomotility 0 per cent, Normal 22.2 per cent, Retrostalsis 11.1 per cent. Appendix (Clamping): Hyperperistalsis 100 per cent, Hypoperistalsis 0 per cent, Normal 0 per cent, Retrostalsis 0 per cent.

They admit that there are many sources of error, as in any review of statistics, and mention the following as the most important: The general condition of the patient, his emotional state, his irritability, the irritability of the stomach at the time and the presence of other foci of disease in the body. They draw the following conclusions:

1. For the past eight years, the records of chronic cholecystitis, with or without cholelithiasis, duodenal ulcer, and chronic appendicitis bearing roentgen-ray notes on the gastric motor function and verified by open operation, disclose gastric hypermotility for gall-bladder disease in 68.4 per cent, for duodenal ulcer in 75 per cent, and for chronic appendicitis in 55 per cent of cases.

2. Experiments purposely carried out on the open surgical abdomen antedating this clinical review give hypermotility for gall-bladder disease in 61.5 per cent, for duodenal trauma in 66.7 per cent, and for appendix disease in 100 per cent of experiments.

3. The motor characteristics of surgical lesions of the stomach are the incisura and pylorospasm (pyloric-sphincter-spasm) in that they probably more frequently occur in the presence of essential disease. Diffuse pylorospasm appears very often "reflexly."

JOHN T. MURPHY.

WOOD, FRANCIS CARTER, and PRIME, FREDERICK. Lethal Dose of Roentgen Rays for Cancer Cells. (*J. Am. M. Assn.*, Vol. 74, No. 5, Jan. 31, 1920.)

The conclusions reached by the authors in their very able article are: 1. Approximately four erythema doses of roentgen ray, given continuously and filtered through 3 mm. of aluminum, are required to kill mouse carcinoma, and five to kill sarcoma exposed in vitro; but occasionally some cells may escape the effects of even six doses.

2. Approximately six erythema doses are required to kill sarcoma cells in vivo as compared to five required to kill the same cells in vitro; and approximately six doses to kill carcinoma cells in vivo, as compared to four required to kill the same in vitro.

3. The in vitro outgrowth from sarcoma tissue after four erythema doses of roentgen ray produced tumors when inoculated into mice.

4. At least five erythema doses are required to kill carcinoma and sarcoma cells in tissue cultures, and at least four to kill embryonic connective tissue cells in cultures.

5. The amount of in vitro growth is no indication as to whether the tumor cell is or is not capable of proliferating in the animal body. The growth observed after lethal doses is evidently due to the slow action of the rays which permits cells potentially dead to wander out into the medium and to complete a division process before their growth momentum is finally checked.

6. Absence of mitolic figures after roentgen ray treatment is not an indication of lack of ability of the cells to grow in the animal body.

7. The practical conclusion which may be drawn from these observations is that the amount of roentgen ray necessary to kill all the cells of a rapidly growing, very cellular, and highly malignant sarcoma or carcinoma in man is between five and seven erythema doses of filtered roentgen rays when the tumor is on the surface of the body. Every centimeter of tissue that covers the tumor makes an additional amount of roentgen ray necessary.

For example when slices of fibroid uterus are used as absorptive material, the galvanometer deflections show that at a depth of 2 cm. 19 per cent more roentgen ray is required; at a 5 cm. depth, 47 per cent more and at 10 cm. depth, 65 per cent more. While many tumor cells may possibly be slowed in their progress and mitotic forms killed at such depths, it is doubtful whether all can be destroyed. The basal-cell tumors and the lymphosarcomas are, as is well known, much more susceptible to radiation. Small superficial, metastatic carcinomas are also, in some instances, more susceptible than is the primary tumor.

They state that soft roentgen rays have a practical therapeutic value only on superficial growths, the penetration being very slight, the spark gap being only from 4 to 8 cm. in the experiments by Kimura. The general tendency at present is to use highly filtered rays with a spark gap of from 8 to 9 inches representing a terminal voltage across the tube of from 80 to 90 kilovolts. When low voltage is used the effective roentgen-ray output from a tungsten target tube is small, the K radiation appearing only when about 70,000 volts are applied to the tube terminals, while a much higher yield is apparent with from 80 to 95 kilovolts.

PIRIE, A. HOWARD, Montreal. The Present Status of Radiotherapy. (*Int. Abstract of Surg.*, Aug., 1915.)

As the terms dose and filtration will be frequently mentioned, it will be well to define what is meant by *x*-ray dose and filtered rays. The unit dose of *x*-rays is known as 10X. This is the quantity which causes epilation. As ordinary light is a mixture of light of varying wave lengths, separable into the colors of the rainbow, so the rays coming from an *x*-ray tube are mixtures of rays of varying wave-length. Those of shortwave-length penetrate the tissue and are called hard rays, while those of long wave-length are non-penetrating and are called soft rays. Both kinds can be used for superficial treatment, but for deep treatment only the penetrating rays, those of short wave-length are of value. Therefore for all deep treatments the non-penetrating rays are removed, so as to prevent injury to the skin and maintain its integrity. This is accomplished by placing a sheet of aluminum from 1 to 3 millimeters thick between the *x*-ray tube and the skin. The rays are then referred to as being filtered.

Cases of splenic leukemia which have ceased to respond to *x*-ray treatment do respond to radium, according to Renon. The difference between the effect produced by radium and *x*-ray may be due to blood passing and repassing during the long application of radium, and so becoming impregnated with its energy. A. David says that radiotherapy produces rapid change in the leucocyte formula, but a time comes when radiotherapy is powerless. By the use of benzol the destruction was checked in the majority of cases, but anemia did not disappear completely, as the drug acts on the red blood corpuscles and hemoglobin. Improper use of benzol is liable to cause lesions of the liver and kidneys.

Parkes Weber reports a case of myeloid leukemia which had already been treated with *x*-ray. The treatment was discontinued and benzol given for 70 days without result. After that *x*-ray treatment was begun again, and marked improvement followed, with diminution in the size of the spleen and liver, and improvement in the blood count. From a review literature and the writer's personal experience one need feel no hesitancy in

stating that radiotherapy is the best treatment at present known for splenic leukemia.

Radiotherapy in gynecology is of value in hemorrhagic metritis and fibroma uteri. The literature at present is so full of reports of successful *x*-ray treatment of Myoma-uteri and metrorrhagia that the writer feels that he need not enlarge on it further. He has omitted any further comment on the subject. Analysis of these successes establishes the fact that myomata and menorrhagia in women over forty are best treated by *x*-rays, and for younger women it is the treatment of choice where operation is contra-indicted. The writer's experience confirms the results reported. He has seen myomata decrease in size and disappear and menorrhagia cease under *x*-ray treatment, and has also seen it reappear after cessation of treatment. He has seen complete cessation of menstruation follow *x*-ray treatment, and has also seen it reappear after cessation of treatment, after menstruation had been suppressed for three months. In fact the ovaries behave under *x-rays* somewhat as the hairs of the head do. The hairs may be made to fall for two months and then grow again, or may be made to fall out permanently, according to the dosage applied.

The use of radiotherapy in malignant disease may be summed up as follows. When the disease is removable by surgery let the surgeon remove it. When entire removal is not possible let the surgeon remove as much as he can, and leave the way open for radium to reach what he cannot. Surgery may become possible after the use of radium in a case inoperable before its use. Radium should not be looked on as an "also ran" to an incomplete operation; but like a boring in the rock for the reception of dynamite, the operation should be a preparation for the use of radium.

Hayward Pinch recommends one millimeter of silver as the best filter for radium, and urges the protection of healthy tissues, especially in the vagina. Packing with gauze is sufficient protection so as to afford the protective effect of distance. Pinch, who has charge of the Radium Institute in London, with a large quantity of radium at his command, recommends that every removable carcinoma should be removad by the surgeon. Treatment by radium yields most gratifying results in carcinoma of the uterus, and the effects of this treatment in inoperable cases are far in advance of those obtained by any other known medical or surgical method. He says that the complete disappearance of fungating growth, arrest of hemorrhage and discharge, healing of ulceration, and relief from pain are phenomena of almost daily occurrence. Care must be taken not to use too much radium or destructive reaction may follow. After the treatment the patient must use a douche twice a day in order to prevent adhesive vaginitis. In carcinoma of the breast Pinch is less enthusiastic in his comment. Many patients exhibit a great susceptibility to radium, the primary growth becomes smaller, and infected glands and subcutaneous nodules lessen or even disappear. Little or no effect appears to be exerted in the prevention of metastatic deposits. In a few patients who had been under treatment for two years he noted that a stage was reached in the treatment when the response to radium failed, and the benefit derived became negligible. In Paget's disease he says the superficial lesion is usually speedily cured by radium, but in cases in which the patient is willing to submit to operation, that procedure should always be adopted.

Sarcoma and lymphosarcoma give excellent results from radium treatment, but melanotic sarcoma is uninfluenced by it. It is important to use large quantities of radium inside and outtide of the growths. The best results are secured in sarcomata of the tonsil and the post-nasal space, the growths disappearing completely with six weeks' treatment (Pinch).

Petersen states that *x*-rays have a very varying effect on sarcomata. Some are refractory and increase in spite of *x*-ray treatment, while others show an astonishing sensitiveness to the rays and melt away like snow before the sun. Hitherto it has not been possible to establish the definite relationship between histological structure and radiosensitiveness. Petersen has collected 45 cases of sarcomata, recorded in the literature, reported cured by *x*-rays. These cases are the work of 25 radiologists. Some of these apparent cures must be discounted, but others are undoubtedly cured, have stood the test of microscopic examination, and had no relapse for several years. Cases of fibrosarcoma, round-celled sarcoma, and spindle-celled sarcoma have remained cured for from 3 to 8 years. But it must be admitted that the percentage of permanent cures of sarcoma by *x*-rays is as yet small.

Heineke, at the tenth congress of the German Society of Radiology, gave some suggestions on the biological action of x-rays. Tumors have the same sensitiveness to x-rays as their parent cells; thus carcinoma of epithelial origin is less sensitive than lymphosarcoma. Periosteal sarcoma is very refractory to x-rays.

JORDAN, ARTHUR. Eighteen Months' Experience with Radium. (*Northwest Med., Seattle,* Vol. XIX, No. 1.)

The object in writing this paper is to bring to the attention of the general practitioner the everyday use of radium rather than to offer a technical paper for the radiotherapist. The following list of cases treated with radium is given and shows uniformly excellent results: Cancer; By far the greater number of malignant conditions treated by us have been lesions found on and about the face. The most frequent lesion has been the basal cell epithelioma, Lupus Erythematosus, Lupus Vulgaris, Nevus Flammeus, Leikoplakia, Keloids.

Technic. The object of the radiotherapist is to reach the deep layers of tissue without destroying the healthy tissues. It must be understood that they do not tie to any particular technic and are of the opinion that one can get as good results from his own as if he followed that of another radiotherapist. There are certain hard and fast rules which should constantly be kept in mind. For instance, when we speak of the use of radium we should refer to the radium element content in the applicator, and not to an indefinite amount of radium. In malignant diseases we must first attempt to reach the deep tissue, which is accomplished by screening. Later in the treatment we can give the full effect of the radium to the superficial tissues. In the fungating type of epithelioma we give a massive dose. Again, where there are large masses of malignant tissue we employ the cross fire.

ORNDOFF, B. H., Chicago. Pneumoperitoneum in X-ray Diagnosis. (*Journal of Roentgenology,* Vol. II, No. 3, Sept., 1919.)

Pneumoperitoneum indicates that the peritoneal cavity has been distended with a medium of a gaseous character. In the early cases air was used, later oxygen and nitrogen have been used. Oxygen seems preferable.

The apparatus used in producing pneumoperitoneum consists of a tank of oxygen, a water-bottle indicator, a pressure gauge, needle, cotton filter, rubber tubing, glass connections, etc.

The needle used may be an ordinary intraspinal needle not less than eight centimeters long. The oxygen may be supplied from an ordinary oxygen tank. The water-bottle indicator is constructed from an ordinary deep, narrow bottle, a double perforated cork and two glass tubes. The inflowing oxygen is conducted by the glass tube about one inch beneath the surface of the water. The outflowing tube passes just through the cork in order to avoid collecting the water thrown up by the oxygen from the inflowing tube. The pressure gauge is an ordinary blood-pressure apparatus graduated to millimeters of mercury. The cotton filter consists of glass tubing filled with absorbent cotton. The cotton filter and rubber tubing connecting with the needle are sterilized in an ordinary formaldehyde sterilizer. The needle is sterilized by boiling.

1. The procedure of producing pneumoperitoneum is not difficult, and while a few important points in technique are essential, they require no special training other than the usual medical training of a physician.

2. The size, position, mobility, relative density, variations in density, contour, contents and cavities of the abdominal viscera can be visualized and studied in a manner which opens to physicians entirely new possibilities.

3. New findings are encountered which seem to invite the conclusions that the basis for possible new clinical disease entities have been established and old clinical entities relegated to obsolete classifications.

4. Peritoneal adhesions between abdominal viscera and the anterior abdominal wall are demonstrated without difficulty. The importance of the functional pathology originating from this source will be studied carefully by the workers in this branch of medicine.

5. Fixation of the gastrocolic omentum to the anterior abdominal wall in seven cases have all shown, as a cardinal symptom, vomiting, which is temporarily relieved by producing a pneumoperitoneum. The symptom returns as the oxygen is absorbed.

6. Perihepatitis, perisplenitis and pericolitis with peritoneal adhesions offer new phases for study of functional pathology of these organs.

7. After pneumoperitoneum has been produced valuable aid in diagnosis is offered by filling the colon, stomach, duodenum, small intestines, bladder and pelvis with oxygen. Variation in the diameter of the walls, changes in relative densities, and the presence of neoplasms are detected before they have reached large proportions, and, consequently, diagnosis and prognosis is rendered more rational and reliable than has heretofore been possible.

8. Post-operative peritoneal adhesions to the anterior abdominal wall may be prevented by keeping the peritoneal cavity distended with oxygen for three to five days, or until the peritoneum is healed.

WEBSTER W. BELDEN.

SCHANZ, ROBERT F. Iodid and Bromid Pastes as Used in Roentgenography. *(J. Am. M. Assn.,* Vol. 74, No. 5, Jan. 31, 1920.)

A serviceable paste should have the following characteristics:

1. It should be non-irritating.
2. It must be thick enough at body temperature, to be retained when injected.
3. It must be free from small lumps, as often it is desired to pass it through a medium-sized needle.
4. Its base should be water-soluble so that it can be easily washed from an injected area.
5. It should be easily prepared and preserved.

The author, after experimentation, found that the three following were most serviceable:

Corn starch is suspended in water and is then placed in the water-bath. It is stirred continuously until a thick paste is formed. Glycerine is then mixed in thoroughly—this forms a glyceride of starch and also prevents the surface film from forming when the paste cools. Then add 15 gms. of iodid or 25 gms. of bromid. These go into solution readily without the addition of more water.

Corn Starch	10 gm.
Glycerin	16 cc.
Water	100 cc.

is the formula of starch paste.

To preserve the paste and render it unfit for bacterial growth when harbored in a tract, 0.5 c.c. of pure phenol or 1 c.c. of a volatile oil, such as oil of thyme, is incorporated. To help the surgeon in following out the tract at the time of operation, the paste is colored a deep blue with a solution of methylene blue.

Irish Moss Paste

Irish Moss	3 gm.
Glycerin	6 c.c.
Water	100 c.c.

The moss is first well washed in cold water, then placed in a beaker, the water is added and the whole placed on the water-bath for fifteen minutes. It must be stirred frequently. The resulting mucilage is strained through muslin, the glycerineadded and the mixture then heated over the water-bath until a thick, jelly-like paste is formed. Then the iodids or bromids and the phenol are added. This paste seems difficult to color.

Tragacanth Paste

Tragacanth (powdered No. 1)	5 gm.
Glycerin	8 c.c.
Water	100 c.c.

Water is added to the tragacanth, the mixture stirred thoroughly and allowed to stand for twenty-four hours. Then the glycerine is mixed in. It is heated on the water-bath for about thirty minutes. This is sufficient to make a thick, jelly-like paste. Then the procedure is the same as in the other pastes.

The simple inorganic salts of iodin and bromin are better and less expensive than the complex organic compounds. The starch paste is the most economical, is quickly prepared, and is very serviceable. The pastes made from tragacanth or Irish moss are more elegant but are more difficult to prepare. The air bubbles found are easily driven off by heat.

They are all non-irritating, are retained sufficiently long to allow of roentgenography and can be easily washed away by a stream of warm saline solution.

FUSSELL, M. H., and PANCOAST, H. K. A Roentgen Ray Sign of Perinephritic Abscess. *(Am. J. M. Sc.,* Vol. CLIX, No. 574, Jan., 1920.)

A curious fluoroscopic finding was observed in two patients. This sign was that the patients in the erect position when fluoroscoped showed a fluid level below the diaphragm. Grasping the patient's shoulders and moving his body from side to side quickly two or three times, produced a distinct wave in the supposed fluid. This could be very clearly seen on the fluoro-

scopic screen. This was explained by Dr. Pancoast as a collection of fluid around the left kidney, which showed waves on its surface when agitated. In both cases the renal region was opened and a huge sac of pus demonstrated within the capsule of the kidney.

In one case—the second—it was noted that with the patient prone the left diaphragm was shown to have its normal arch, and revealed no evidence of fluid below the diaphragm. With the patient erect, however, the left diaphragm was flat and immobile, and had lost its normal arched position. The diaphragm was not observed in the first case.

Of necessity, pus about the right kidney will not be expected to give this sign, as the liver intervenes between kidney and diaphragm.

Roberts, Dudley. Certain Limitations of Roentgen Ray Diagnosis of Gastrointestinal Diseases. *(J. Am. M. Assn.,* Vol. 73, No. 20, Nov. 15, 1919.)

The roentgenologic diagnosis has developed with such marvelous rapidity that a great degree of caution should be observed in directing attention at the present time to its seeming limitations. It must be conceded that roentgenology has put gastro-intestinal diagnosis on a new and sounder basis, changing to a great degree the current conception of the meaning of abdominal complaints, and demonstrating some abnormalities with unerring accuracy. Nevertheless there are definite limitations to the extent to which this method can be used.

By roentgenographic examinations we can visualize the shape, size, contour and position of the various parts of the gastro-intestinal tract when properly filled with opaque substances, and we can with reasonable accuracy roentgenograph the outlines of the liver and kidneys, but it must be admitted that we cannot visualize the changes of the structure of the abdominal organs. A negative roentgen ray diagnosis of a gastro-intestinal lesion should never be regarded as final in the exclusion of gastro-intestinal disease.

The study of the esophagus by the fluoroscopic and roentgenographic method has been an important step in the clinical study of its abnormalities, but we must admit that the passage of the meal through the unobstructed esophagus is rapid, and the filling too incomplete to make for satisfactory examination. The differentiation of spasm from annular growth in the cardia is sometimes made with disastrous results. It should be considered merely an aid to other methods of diagnosis of conditions in the esophagus, and not of the same value as in the examinations of the rest of the gastro-intestinal tract, because the esophagus can so readily be examined with the esophagoscope.

The stomach is in many respects the most easily roentgenographed of all parts of the alimentary tract. In only a small majority of cases will adequate fluoroscopic and plate studies fail to show a gross lesion. Ulcers or cancers on the posterior wall of the stomach, unless they encroach on the curvatures, fail on the immediate plate to give definite filling defects. Then there is a definite group of cases that resembl ulcer in history and laboratory findings, while the roentgenographic findings are absolutely negative. The roentgenographic determination as to whether a lesion is active or healed is possible in many cases, and the differentiation between ulcer, cancer and syphilis may also be made with a reasonable degree of certainty.

It is now possible to visualize gallstones in a large majority of cases: and frequently the chronic thickened gall-bladder is definitely shown. All stones and all chronic affections of the gall-bladder cannot be demonstrated. It is not correct to consider the gall-bladder that can be visualized a pathological one.

The diagnosis of ileocecal incompetency can be made by the opaque enema, but the clinical significance is extremely doubtful under such artificial conditions. The roentgenographic diagnosis of appendix has become popular in recent years, although it rests on a very insecure foundation of established fact. The study of the colon is on the whole satisfactory.

Note: It might be well to mention the fact that although Dr. Roberts is certainly correct in several of his statements, and all agree that great care must be exercised in interpreting roentgen findings in the gastro-intestinal tract and that this examination is not to be considered all that is necessary in the diagnosis of gastro-intestinal lesion, we still find that the majority of men do not agree with Dr. Roberts in his statements regarding the unsatisfactory examination of the esophagus, and also in his statement regarding the fact that lesions on the posterior or anterior wall of the stomach do not show unless they are of sufficient size to

encroach upon the curvatures, because no gastro-intestinal examination is complete without making plates of the stomach in the lateral position and also fluoroscoping the patients in this position. No doubt a good proportion of the cases mentioned in the article as "a definite group of cases that resemble ulcer in history and laboratory findings while the roentgenographic findings are negative" will be found to be cases of obstruction at the duodenal-jejunal angle (the angle of Tritz) with resulting elongation and dilation of the duodenum. This type of case clears up both clinically and symptomatically when operated upon the operation consisting of freeing the adhesions or doing a duodena-jejunostomy.

WEBSTER W. BELDEN.

TYLER, A. F. Syphilis of the Great Vessels. (*Am. J. Syphilis,* Vol. IV, No. 1, January, 1920.)

Syphilis of the great vessels is so closely linked with aneurysm that the discussion of one is practically a discussion of the other. The literature of this condition dates back to about 200 A. D., when Galen first described aneurysm, differentiating between the traumatic type and the ordinary idiopathic dilatation. At that time, of course, the causative factor was not definitely known, and so every patient in whom an aneurysm is found was considered to have had previous syphilitic infection unless otherwise proved. There are a number of types of aneurysm, the ascending arch of the aorta being the most frequently involved. That part of the aorta above the diaphragm was affected with 75 per cent while 25 per cent of the aneurysms were found below the diaphragm. Of the 75 per cent which occurred above the diaphragm, 60 per cent originated in the ascending portion of the arch. The most frequent type of the ascending portion of the arch is the sacculated aneurysm. Of the descending arch and thoracic aorta, the fusiform aneurysm is the most common. Some one has said that aneurysm of the ascending arch of the aorta is essentially syphilitic, while that of the remaining portion of the thoracic aorta is more apt to be arteriosclerotic. The *x*-ray when used in conjunction with and as an aid to the other means of physical diagnosis has been of great help, especially in making a positive diagnosis of aneurysm of the aorta. The fluoroscopic image should be used in conjunction with the study of properly made *x*-ray plates. When viewing the chest in which one is suspicious of some vascular disease, it is well to study it for a considerable period of time in different positions. My custom is to make a general survey of the chest directly from in front, then to focus down upon the heart and aorta. If there is an increase in the width of the aorta, one can know in which direction this increase extends and can see whether there is definite pulsation. Then the patient should be turned with the rays passing through in the right oblique position, so as to determine whether the increase in the aortic shadow is definitely connected with the great vessels or due to a tumor within the mediastinum. Then the patient should be turned to the left oblique position to see whether it is the ascending, transverse, or descending portion of the arch, or the thoracic aorta, which is the site of the disease. The plates, of course, will give us definite information as to whether there is an erosion of the sternum or vertebrae, because they are more reliable for this information than is the fluoroscopic image. Aneurysm of the aorta must be differentiated from enlarged heart and aortic insufficiency. Since the heart is enlarged in less than half the cases of aneurysm of the aortic arch, one must always be on guard in making a diagnosis of aneurysm when an enlarged heart is found. The aneurysm must be differentiated from a simple dynamic pulsation of the aorta, which is more pronounced in some patients than in others. One of the most frequent errors in diagnosis is when there is a dislocation of the heart due to a curvature of the spine. The physical and *x*-ray findings in this condition are very deceiving, unless one looks very carefully and is very thorough with his examination. Another frequent source of error is in the solid tumor of the mediastinum. One, of course, would not expect to see pulsation in a solid tumor, but it has been my observation in a number of cases that the pulsation of the aorta may be transmitted to the tumor mass, so that one really observes movement of the tumor which corresponds to the beat of the heart. In differentiating tumor from aneurysm I have found considerable help by having the patient swallow a little opaque material, which will show the path of the esophagus and show whether the tumor in-

volves the esophagus or whether there is simply pressure against it. Another source of difficulty in differentiating aneurysm from tumor of the mediastinum is found when the sac has become filled with an organized blood clot. In this type no pulsation will be observed. One must differentiate aneurysm from pulsating pleurisy and from tuberculosis of the spine with an accumulation of tuberculous *detritus*.

KELLY, HOWARD A. and NEILL, WILLIAM, JR. Radium Therapy. (*Am. J. Surg.*, Vol. XXXIII, No. 12, December, 1919.)

He advocates as a method of application the following: if he wants to apply a gram of radium, say inside the uterus, its very bulk in the form of radium salts is a hindrance, so for reasons of convenience as well as security against loss, it is better, when there is enough available to justify the expense of employing a technician, to dissolve all the radium salt in a weak acid solution in a closed glass receptacle; from this its active gaseous principle, called "emanation" by Rutherford is pumped off day by day, with a mercury pump and conveyed to a minute capillary glass tube, which is then sealed, cut off and taken to the patient's bedside to be used. The greater convenience of this method of application will be seen when he states that all of the active material of a whole gram of radium in the form of a salt (which itself would fill a small teaspoon) can thus be accumulated in a tiny intensely active glass button not as large as the head of a common pin. A use that can be made of the emanation, which is of extraordinary value, is by planting it in the tissues permanently in minute capillary glass tubes, each containing from two to three or five millecuries of the gas. A resistent affected gland will sometimes melt down with great rapidity when treated in this way. A most important factor in any successful treatment is the hearty coöperation of the patient. It almost invariably takes time, sometimes several weeks, often when duty and the heart strings are pulling strongly in the homeward direction. The new field of radium therapy embraces: 1. Hodgkin's disease, 2. Myelogenous leukemia. 3. Splenomyelogenous leukemia. 4. Lymphosarcoma. 5. Carcinoma of the inner canthus. 6. Epithelioma of nose. 7. Cancer of the thyroid. 8. Epithelioma of back of head. 9. Cancer of the cervix in three stages. 10. Fibroid tumor. 11. Mediastinal sarcoma. Great and irreparable harm can be done by overzealous, too intensive and prolonged treatments, when even if the patient escapes serious injury, the tissues surrounding or overlying the part being treated may become so irritated that further treatment has to be suspended indefinitely and a golden chance of curing the disease may be lost. What hope is there in the use of radium in cancer of the breast? And what is the best course to pursue in any given case? The decision here involves a fundamental principle in radium-therapy as applied to cancer—namely, *it must be intensive*, it must be a direct application to a given, recognizable lesion, repeated at intervals. It is sufficient to simply spray a lymphosarcoma to dissipate it, but spraying will not do for any form of carcinoma, which must be handled as with a sledge-hammer blow delivered often repeatedly right on the affected spot. The difficulty in a cancer of the breast is this—in an advanced cancer it is manifestly impossible, antecedent to an operation, to know certainly in just how many foci the disease is distributed, and the attempt to treat indeterminate areas of disease violates the principle enunciated, of repeated intensive treatments to each affected spot. Cancer of the neck of the uterus offers the therapist a remarkable opportunity, for the use of radium here bids fair in the near future to drive our surgery entirely from the field. A most precious and fruitful field for radium-therapy lies in the recurrent cancers at the vaginal vault. In "idiopathic" or so-called myopathic bleeding uteri, that is to say in all persistent uterine bleeding without gross demonstrable cause, about the time of the menopause, radium is the one supreme remedy. One of radium's most wonderful fields is the treatment of fibroid uteri; here, perhaps in nineteen out of twenty, we can check the bleeding and stop the growth of the tumor, which shrinks more or less rapidly and sometimes disappears entirely. This, too, may be a matter of one or two brief courses of treatment, external as well as internal.

MEYER, WILLIAM H. Roentgen Therapy in Gynecology. (*N. York M. J.*, January 24, 1920.)

Since the vulva, vagina and cervix may be

classed as superficial structures in so far as the direct application of the rays is a possibility, a classification here need be no different from that of diseases of the skin and tangible mucous membranes in any other portion of the body. Superficial lesions will naturally fall into three groups: 1, those to be benefited by stimulation; 2, those in which an inhibitory action is desired, and 3, those conditions in which total destruction is the aim. Superficial conditions involving the skin and adjoining mucous membranes might properly be left for consideration in the field of dermatology; however, he felt that a few words concerning epithelioma, rodent ulcer, and superficial malignancy should be considered. The possibility of cure of superficial malignancy by radiant energy is practically conceded in every quarter. A significant point is that since employing the absorption rate as a basis for our dose measurement we have passed our fiftieth consecutive case of superficial malignancy, with satisfactory results. In some of these cases the patients are now in their third year following the first treatment, and to all appearances remain permanently well, differences in penetration and filtration are employed to suit the individual case. The estimated absorption, however, is the dose factor in each instance, and the results have been uniform whether the lesion was purely cutaneous or at the mucocutaneous junction; whether prickle cell or squamous cell in type. They are now producing this result in a single sitting, the full treatment to a single area requiring not more than fifteen minutes. A summary means just this, that complete resolution is to be expected only if a lesion is so situated that the dose known to be destructive to the particular type of cell can by multiple area cross-fire be brought to bear. In malignancy, superficial or deep, the desired result will have been obtained under the following conditions: a, Destruction of the malignant cells; b, inhibition to neighboring unhealthy tissue; c, stimulation to the surrounding normal and healthy tissue. In deep seated and more widespread malignancy, usually the very best that one can hope for is: a, An inhibitory action on the malignant cells; b, stimulation of surrounding normal tissue. The gynecological conditions amenable to röntgen therapy may be classed as perhaps a uterine hemorrhage, menorrhagis, metrorrhagia, symptoms of the menopause, and uterine fibroids. A single treatment of from forty to ninety minutes' duration depending upon the size of the patient, a permanent cessation of the menstrual function and of hemorrhage can be produced. When more than one treatment is to be given, from four to six weeks should elapse between applications, not alone to await full reaction, but to allow the skin to recover from the cumulative effect of the rays. The fibroid growths best suited to irradiation are the intramural type. The subperitoneal and particularly the pedunculated variety, had best be removed surgically. The submucous or polypoid type of fibroids are practically contraindications to the use of radiotherapy. When complications, and above all malignancy, do not exist, the results are uniformly good. A few words concerning the logic of dosimetry by the estimation of absorption may be acceptable: 1. The amount and pressure of current energizing the röntgen tube can be metered. 2. The quality and quantity of x-rays generated are measurable. 3. Various methods of surface dosimetry have been devised. Yet with all these measures combined, though the incident surface dose appear the same the biological reaction may differ, *i.e.,* the more penetrating the rays and the greater the filtration, the less the possibility of reaction with the same full measured incident dose.

Knox, Robert. Examination of Liver, Gall-Bladder, and Bile Ducts. (*Arch. Radiol. & Electroth.,* No. 228, July, 1919; No. 229, August, 1919; No. 230, September, 1919; No. 231, October, 1919.)

The recorded observations of workers in various parts of the world, notably—Thurston Holland in England, Ledoux Lebard in France, Carmen and Miller, Leonard and George, and J. T. Case in America, and McLeod of Shanghai—gave cause for thought and led to a careful study of the literature of the subject, the technique employed, and a critical examination of the radiograms published.

This was followed by experimental work with calculi, comparisons of densities on tissues absorption of radiation, and particularly the inquiry into photographic processes employed. The investigations were carried out under the following heads:—

(1) Anatomical considerations.

(2) Pathology of gall-stones, and classifications in chemical compositions.
(3) Experimental investigations on absorption, coefficients of gall-stones and surrounding tissues.
(4) Radiographic appearance of gall-stones.
(5) Technique of the examination.
(6) Situations in which gall-stones may be found.
(7) Differential diagnosis.
(8) Pathological gall-bladder.
(9) Record of cases.
(10) Résumé of the literature and general conclusions.

The author considers the anatomy of the liver and gall-bladder in a brief but very comprehensive manner:—

Gall-stones,—these are of frequent occurrence, especially in people of middle age and those of sedentary habits; but they may occur at any age. They occur more frequently in females.

The calculi occur singly or in numbers. Of the solitary gall-stones there are two principal varieties, which are—the oval, composed almost entirely of cholesterin, and second, acorn-like masses, which are composed of cholesterin, bile-pigments, etc.

For best classifications of gall-stones the author quotes from Adami's Pathology. He, after experimental investigation on the absorption coefficient of various constituents of gall-stones and comparisons with the tissues around the gall-bladder area—arrives at the conclusion that it should be the routine practice to expose several plates to the radiation of tubes of different penetration, and to develop the plate to give the maximum of contrast. For this purpose he found that tubes of moderate vacuum gave negatives showing greater contrast than those of higher vacuum.

After the experimental work of the radiographic appearance of gall-stones removed from the gall-bladder or bile ducts, the author finds one point impressed upon the mind—that is the fact that in no instance have the rays actually failed to make an impression upon the plate.

He finds further that stones composed of pure cholesterin when super-imposed upon the liver tissues cast no shadow. He states that in the experiments and photographic records of gall-stones and kidney stones, showing the variation and density with the exposure of tubes of different vacuum, that by the use of the penetronometer it was possible to ascertain the absorption of coefficients of each group.

In his detail experiments, carried out to ascertain the absorption equivalent of gall-stones, he mentions many good points and states that, as a rule, a stone of average density will show through sixteen millimeters of aluminum—which thickness of aluminum he found absorbed approximately the same amount of radiation as the human tissues in the gall bladder region.

Another point of interest noted was—that sixty-five per cent. of the unfiltered radiation is absorbed by the first inch of tissue, while at a depth of two inches the total absorption is ninety-one per cent. of the unfiltered rays against seventy-seven per cent. of the filtered rays. At two inches in depth the curves practically meet for the two types of rays, and proceed onward together. This clearly demonstrates that the rays from a very soft tube can have very little photographic action when they are passed through the tissues of the bodys, as they must be when *x*-raying for gall-stones.

In his discussion of technique for the examination of the liver, gall-bladder, and bile-ducts he lays especial emphasis on the important subject of preparation of the patient, which is now practiced by all Roentgenologists, and the salient points of which all thorough carthax is no solid food is to be taken the morning of the examination, and holding of the breath while exposure is being made. He differs from most Roentgenologists in rather prefering that the bowel be distended with gas than otherwise.

Under the head of position of the patient he advocates:—

(a) Patient prone, with plate beneath the anterior abdominal wall, tube behind the patient.
(b) Patient supine, the plate on the posterior aspect, and the tube in front of the patient.
(c) The lateral position.

In discussing the lateral position, he mentions the great value of it in making a positive diagnosis between gall-stones and renal stones, and says further that no examination of these regions is complete without a lateral plate.

He then takes up in a most interesting and

comprehensive manner the differential diagnosis and positions in which gall-stones are to be found.

In his able discussion of the pathological gall-bladder, he mentions the conditions which can be diagnosed by the Roentgen rays as stone, adhesions, distended gall-bladder containing mucous or mucopurulent material; all of which, from their frequency, are well understood by all Roentgenologists. He states that in exceptional cases a normal gall-bladder, distended with bile, may be shown. Some of us will readily agree, while perhaps the majority will disagree, being of the opinion that a gall-bladder which shows a shadow is pathological.

He then takes up at length the clinical side of these cases and shows many interesting illustrations.

He also goes into other conditions, which he has been able to diagnose with the Roentgen rays: among which he mentions—Hydatid cyst of the liver and sub-diaphragmatic abscess and neoplasm. The latter only can be diagnosed as a tumor, and no differential diagnosis made.

THE AMERICAN JOURNAL OF ROENTGENOLOGY

Editor, H. M. Imboden, M.D., New York

VOL. VII (NEW SERIES) APRIL, 1920 No. 4

OIL-IMMERSED X-RAY GENERATING OUTFITS*

By W. D. COOLIDGE

Research Laboratory, General Electric Company

SCHENECTADY, N. Y.

I. INTRODUCTION.

THE medical application of the x-rays has almost invariably been attended by the possibility of accidental electric shock to either the patient or the operator. In the early history of the art, contact with the high tension circuit involved only annoyance and discomfort; but with the advent of high-power installations, that which had been merely a possible source of annoyance became a real danger.

This danger could, at any time, have been eliminated by putting the entire high tension system, including the tube, into an earthed metallic enclosure. This method, however, when applied to earlier forms of x-ray apparatus, would in general have rendered them bulky and, mechanically, relatively inflexible.

With the advent of a self-rectifying x-ray tube, which is stable and can be made very small, it became interesting to mount the x-ray tube inside of the transformer tank and in the same oil with the transformer. The following consists of a description of a small experimental model of such an outfit, together with a discussion of some of the possible modifications and a summary of the inherent advantages and limitations of the method.

II. DESCRIPTION OF A SMALL EXPERIMENTAL MODEL.

1. *General Description.*—A complete oil-immersed outfit is shown in Fig. 1. The rectangular metal box, adjustably mounted on the tube stand, contains the x-ray transformer and, below this, the special x-ray tube. A low tension cable is seen leading from this, the generating outfit, to the control box at the right of the picture. A second cable, attached to the other end of the control box, leads to the supply mains.

A side view of the generating outfit in partial cross section is shown in Fig. 3. (In this case the cone has been removed and the outfit has been rotated through an angle of 180° from the position shown in Fig. 1, so that the x-ray tube is now above instead of below the transformer.) Fig. 4 shows a partial sectional end view. In Fig. 3, 1 and 2 are the high tension coils of the transformer. The tube is mounted directly over these. It is made of thick lead glass with a small lime-glass window which is set to face a thin re-entrant window in the bakelite cover, 3, of the tank. The x-rays which emerge from the tank have to pass through these two windows and a thin intervening layer of oil.

To permit of operation in all positions, two oil-expansion chambers, 4 and 5, in Fig.

*Read at Twentieth Annual Meeting of THE AMERICAN ROENTGEN RAY SOCIETY, Saratoga Springs, N. Y., Sept. 3–6, 1919.

4, are provided at the bottom, and the balance of the tank is completely filled with oil. (One of the oil-expansion chambers, 5, is also seen in Fig. 3.)

The tank is of metal, and the cover, 3, is of bakelite. A thin layer of aluminum may be mounted on top of this and metallically connected to the tank. If then the tank is connected to earth, the whole high tension system is inside of an earthed metal enclos-

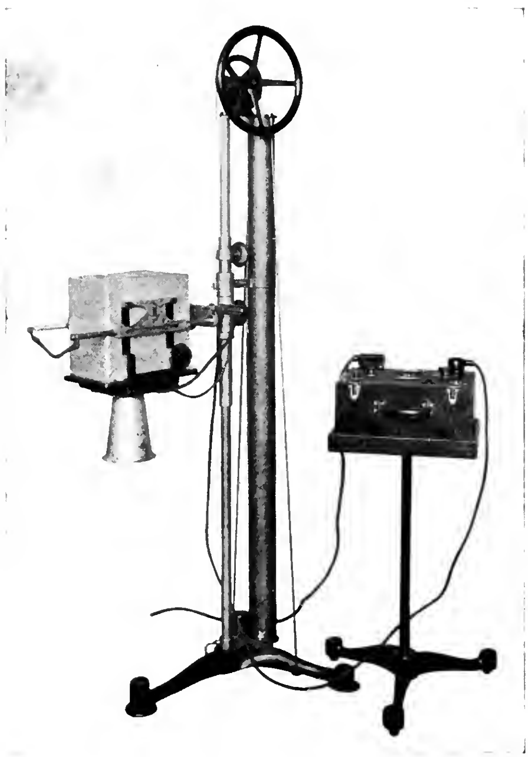


FIG. 1.

ure from which nothing but x-rays can emerge. The high-tension danger is then seen to be completely eliminated.

The generating outfit, as shown in Fig. 3, is suitable for 10 milliamperes at 60000 volts (useful), and weighs 54 pounds. Light weight is of course desirable to promote ease in handling. Furthermore, the weight of the generating outfit determines the weight and bulk of the supporting stand.

2. *The Transformer.*—The transformer is made as small as is consistent with the satisfactory operation of a tube rectifying its own current and carrying the above mentioned load.

3. *The Tube.*—As the bulk of the metal tank which is to contain the transformer and tube is partly dependent on the size of the latter, it becomes desirable that the tube shall be small. There is also another reason for this, for the smaller the bulb and the shorter the anode arm, the shorter will be the heat path from the focal spot to the outside cooling medium, and, hence, the more effective will be the cooling of the anode.

As has been pointed out elsewhere,[1] the size of bulb may be reduced by the use of thick glass. This brings with it the same improvement in operation in oil as it does in air.

For operation in oil, the side arms of the tube may be made very short. (For use in the air they have to be relatively long to prevent arc-over between terminals and to prevent leakage over the surface of the glass, especially in damp weather.)

Fig. 2 shows a full size cross-sectional drawing of the tube, which operates well in oil at 60000 volts (useful). Both 5 and 10 milliampere models have been built, and the same design with the same dimensions, but with larger focal spots, should be equally well suited to tubes of higher current-carrying capacity. Except for a small transparent window of lime glass, this tube is made throughout of glass containing 55 per cent by weight of the element lead.[2] This glass offers the same protection as sheet lead of one-fourth its thickness. The wall-thickness of the bulb is ¼ inch, hence the protection offered is equal to that of 1/16 inch of sheet lead.

As the outer end of the copper anode rod is in direct contact with the oil, no radiator is required.

[1] W. D. Coolidge, AMERICAN JOURNAL OF ROENTGENOLOGY for July, 1919, pp. 8-10.

[2] With the oil immersed type of outfit, x-ray protection could readily be obtained by lining the tank with sheet lead, but weight and bulk are saved by securing protection through the use of the high lead-content glass for the tube.

4. *Air Tanks to Permit of Operation in Any Position.*—The location of the tube in the same oil with the transformer results in a greatly increased heating of the oil, and, hence, in a greatly intensified oil-expansion problem. Of, say, 1000 watts of electrical energy delivered to the primary of the transformer, all but about 0.03 watts (the energy in the useful *x*-ray beam which comes out through the tube-window) will be finally delivered to the oil in the form of heat energy.

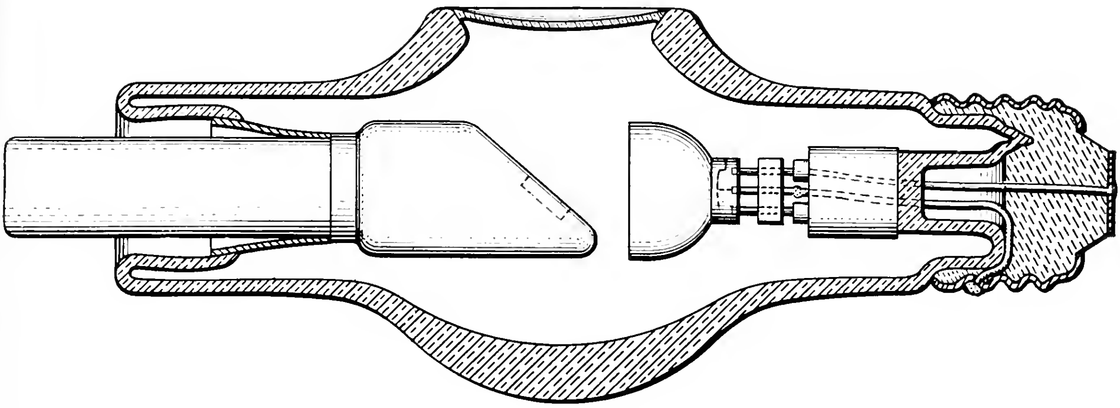


Fig. 2.

The tank and other metal parts involved, expand relatively little, but the oil expands strongly on heating. As a result, with the outfit in question, there is an oil expansion of 10 cubic centimeters for each degree C. of temperature rise.

A natural way of taking care of this would be to leave an air space in the top of the transformer case, and then, as the oil expands, it would compress the air in this space. But to save weight and bulk, the tank is made as small as is safely consistent with the required high tension insulation. Such a transformer could be operated when right side up, but in certain other positions it would be found that there was air where there should be oil, and that the transformer, if operated, would break down.

The field of usefulness of the device is greatly extended by making it possible to operate it in any and all positions. This result is attained by the use of the air chambers, 4 and 5, in Figs. 3 and 4. These air chambers are made of thin sheet metal and connect in each instance with the main tank by means of a metal capillary tube (6 and 7) leading to the center of the chamber. Such an amount of oil is originally put into each of these tanks that, even at the lowest temperature to which the device will ever be subjected, the inner end of the capillary will always be below the level of the oil in the chamber. The balance of the chamber is filled with air at atmospheric pressure. The main tank is filled full of oil so that the only air in the device is that in the special air chambers.

Figs. 5 and 6 show the position of the oil level with respect to the inner end of the

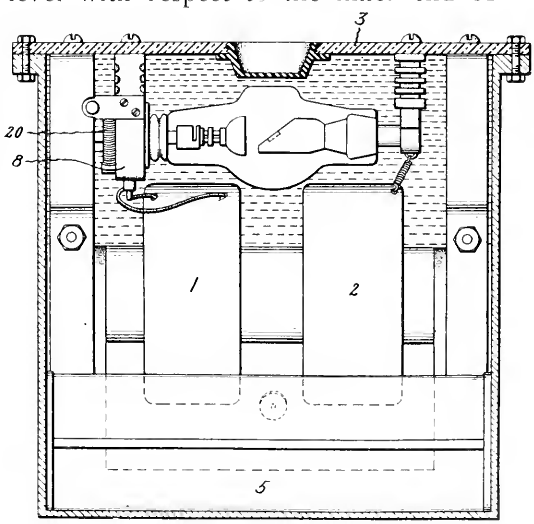


Fig. 3.

capillary tube, with two other positions of the air chamber 4. In no position of the chamber can the air escape into the main tank.

5. *Allowable Temperature Range of Operation.*—With the design in question, the total amount of oil involved is 11200 c.c. The total volume of air at atmospheric pressure in the tanks is 710 c.c. If the oil is allowed to expand until this volume of air is reduced to 3/4 of this amount, the pressure on the inside of the tank will be 4/3 of what it was and will amount to 5 pounds per square inch above the atmosphere (neglecting the effect of temperature acting directly on the gas pressure). This is a reasonable pressure for the transformer tank in question and allows an oil expansion of 177 c.c. As the oil expansion is 10 c.c. per degree C., an expansion of 177 c.c. will correspond to a temperature rise in the oil of 17.7°C. above the 20° at which the case was filled.

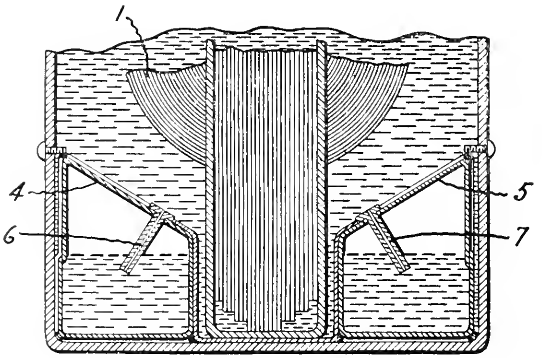


FIG. 4.

As has been said, the air tanks were originally filled more than half full of oil; enough so, in fact, to allow the oil temperature to drop to 0°C. before air can escape from the air tanks. The outfit as it stands then can be conservatively operated with an oil temperature ranging from say 10° to 38°C.

This allowable temperature range can, of course, be extended by the use of larger air tanks.

6. *Allowable Time of Continuous Full-Load Operation.*—Assuming 18°C. as the allowable temperature rise above that of the room, it is interesting to calculate how long the outfit can be continuously operated with 10 milliamperes at 60,000 volts.

The electrical efficiency of the transformer has not been measured, but for this rough calculation it may be assumed that 80 per cent of the energy put into the primary is delivered as high tension electrical energy to the tube. In this case there is an input into the transformer of $\frac{600}{.80} = 750$ joules per second $= \frac{750}{4.2} = 180$ calories per second.

The heat capacity of the system is 6000 calories per degree centigrade.

To raise the temperature 18°C., will call for operation for $\frac{6000}{180} \times 18 = 600$ seconds $= 10$ minutes. This time could be extended by the use of larger air tanks, which would permit of a greater allowable temperature range.

7. *Wiring Diagram of Generating Outfit.*—A schematic wiring diagram is shown in Fig. 7, in which 21 is the low tension coil of the transformer and 1 and 2 are the high tension coils. Coil 23 consists of but a few turns of relatively coarse wire. It is electrically connected to the high tension coil 1, and serves as a source of heating current for the filament of the *x*-ray tube. The filament

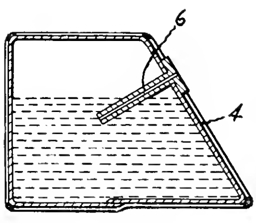


FIG. 5.

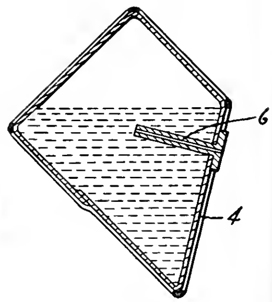


FIG. 6.

current is controlled by a little rheostat 8. Wires lead from the inner ends of the high tension coils out through the metal tank, indicated in the figure by the dotted rectangle, to 24, a milliamperemeter located in the control box. At the bottom of the figure,

a connection is shown running from the metal tank to ground.

8. *Mechanical Means for Adjusting Rheostat in Filament Circuit.*—Fig. 9 is a sectional end view of the upper portion of the generating outfit. (For the sake of clearness, it is drawn to a larger scale than the corresponding side and end views, Figs. 3 and 4.) It shows a mechanical means for adjusting the rheostat, 8, in the filament circuit, from outside the tank. (See also Fig. 8, which is a length section of the rheostat.) The little rheostat consists of a spiral of resistance wire, 20, which is mounted on a circular insulating support, which also carries the receptacle into which the cathode base of the tube screws. The rheostat contact arm, 10, and the two ratchet wheels, 11 and 19, are rigidly connected together and rotatably mounted on a horizontal shaft. The teeth of the two ratchet wheels point in opposite directions. The metal fingers 12 and 13 are made of flat spring material and are carried by the bakelite push-rods 9 and 18. Each of these fingers engages with one of the ratchet wheels. If one of the push-rods, 9, for example, is alternately pushed and released, it produces a clock-wise rotation of the rheostat contact-arm 10. A similar use of the other push-rod results in counter-clock-wise rotation of 10. The push-rods are operated by means of the push-buttons 14 and 15, each of which is attached to a flexible diaphragm in the side wall of the metal container. For greater flexibility, pieces of Sylphon tubing, 16 and 17, are used in place of flat diaphragms. The inner surface of each flexible diaphragm rests against the end of one of the push-rods.

One push-button then serves to increase the filament current and, hence, the milliamperage flowing through the tube, while the other serves to lower it.

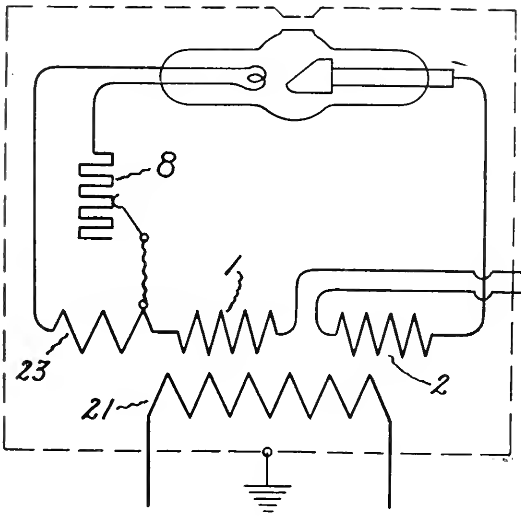


FIG. 7.

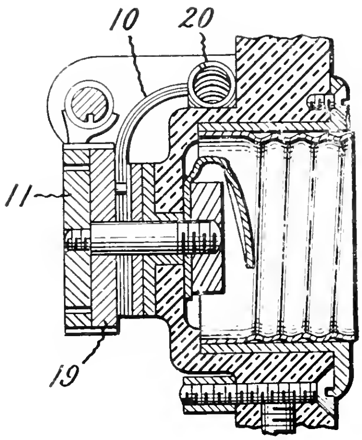


FIG. 8.

9. *The Control Box.*—This is, with a few changes, like one which has already been described in a paper on apparatus for portable work.[3] It is shown in Fig. 10 and contains an auto-transformer with a multiplicity of taps and corresponding special switch. By means of this combination it is possible to vary the voltage supplied to the x-ray transformer by steps of 2 volts through a range of 32 volts.

The voltage delivered by the auto-transformer to the x-ray transformer is indicated by a voltmeter, and the corresponding high tension voltage is known from a sphere-gap calibration made before the transformer was put into the tank.

Current passing through the tube is shown by a milliammeter, which is connected in to

[3] l.c. pp. 13-16.

the middle point of the high tension secondary. There is also a circuit-breaker, time-switch, pilot lamp and push-button *x*-ray switch.

10. *Method of Operation.*—If the voltage is to be kept constant, at 60,000, for example, the operation is very simple. With this particular outfit, a sphere-gap calibration has shown that for 60,000 volts and 5 milliamperes, a primary voltage of 105 is required. The resistance in the filament circuit is then adjusted so that the tube carries

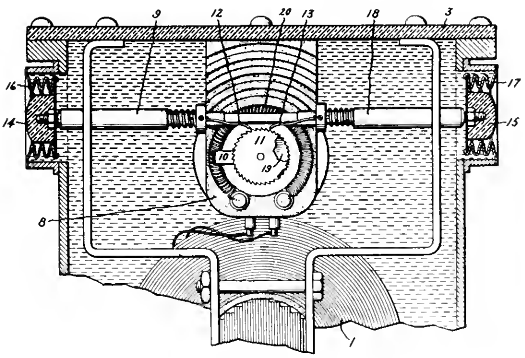


Fig. 9.

5 milliamperes when the primary voltage is 105. It should then be unnecessary again to touch this adjustment of the rheostat in the filament circuit. The milliamperage can be subsequently controlled by the auto-transformer switch, and as the following data will show, this can be done without appreciably affecting the high tension voltage. This is due to the fact that the filament current is determined by the primary voltage and that the electron emission goes up so very rapidly with the filament current.

Primary Volts	*Milliamperes*
101	4.2
104	6.0
106	8.7

In the above table, the primary voltage has been increased by 5 per cent, and this has caused an increase of 107 per cent in milliamperage. A sphere-gap calibration of the transformer shows that the corresponding secondary voltage increase was only 3 per cent. In other words, the above method of regulation made it possible to increase the milliamperage 107 per cent while the secondary voltage increased only 3 per cent.

This method of operation has a great deal to recommend it, especially in radiographic work. If the line voltage is constant, there is nothing to do in making the exposure but to set the time switch and press the button. When the line voltage is very variable, one has merely to see that the voltmeter reading is right before closing the switch, and then, if necessary, operate the auto-transformer switch during the exposure to hold the milliamperage constant.

III. AIR COOLING OF AN OUTFIT FOR CONTINUOUS OPERATION.

For continuous operation or for any sufficiently severe service, the cooling of the oil could be facilitated by the use of a fan or blower and cooling vanes on the outside of the tank. In this case it would also help to make the tank of some good heat-conducting metal, such as copper.

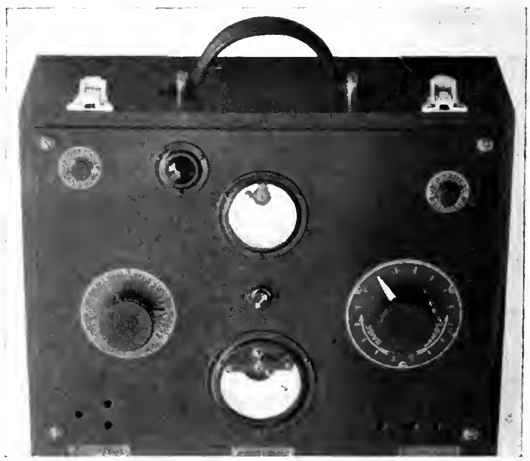


Fig. 10.

IV. WATER COOLING FOR THERAPEUTIC OR OTHER HEAVY DUTY WORK.

Cooling coils of copper tubing could be placed inside of the oil and at a safe distance from the high tension system, or such cooling coils could be soldered to the outside of

the tank. In either case, tap water could then be safely passed through the cooling coils. It will be seen that this is entirely different from the ordinary water-cooling of an *x*-ray tube, for it does not in any possible way endanger the patient. Nor does it necessitate insulating the cooling water. Furthermore, owing to the absence of corona, rubber tubing can be satisfactorily employed as a flexible means of getting water to and from the copper cooling coils. (Rubber disintegrates very rapidly in the neighborhood of high tension discharges.)

V. DIRECT WATER-COOLING OF THE ANODE.

This is also possible with the oil-immersed system, for the tubular anode rod can be soldered in to a metal plate, and this plate can, in turn, be fastened with a gasket into a hole in the wall of the tank. In this case it becomes desirable to connect the inner end of the high-tension winding directly to the metal tank and thence to earth.[4]

Fig. 11 shows a sectional view of a 40 milliampere, 60,000 volt model of this type which has been built. The schematic diagram of connections is shown in Fig. 12. In the light of the other diagrams, these figures are almost self-explanatory.

The cathode end of the *x*-ray tube is attached to a socket containing a little rheostat, which is flexibly mounted on the single high-tension coil of the transformer. The inner end of this high tension coil is connected through a milliammeter to the metal tank and thence to earth. The anode end of the tube is also electrically connected to the metal tank. The anode is cooled by tap water entering at *a* and leaving at *b*.

As the transformer is so small, and as this model was intended for continuous full-load operation, a water-cooling coil, *c*, is shown soldered to the outside of the metal container.

A window of bakelite or aluminum or some other material transparent to *x*-rays is mounted in the wall of the metal tank opposite the transparent window in the *x*-ray tube.

VI. FILAMENT HEATING FROM AN EXTERNAL SOURCE.

For certain applications, the cathode end of the tube may advantageously be con-

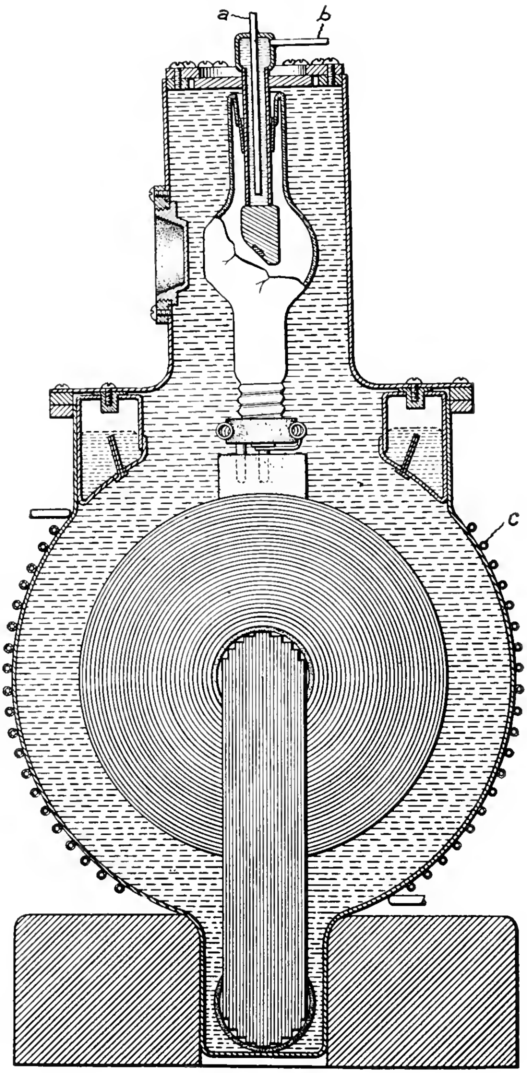


FIG. 11.

nected to the metal tank and to earth. Such an arrangement is shown diagrammatically in Fig. 13. The transformer is here seen to have only one high tension terminal. The

[4] For very high voltage work in air such a system is objectionable, for it results in increased corona trouble. This objection does not hold, however, in the oil-immersed outfit.

above system makes it possible to have the filament lighted before closing the *x*-ray switch (thus doing away with the time-lag which is otherwise present), and brings the control of filament temperature outside of the oil and, if desired, makes it entirely independent of the high tension voltage. This is, of course, conducive to extreme flexibility of operation.

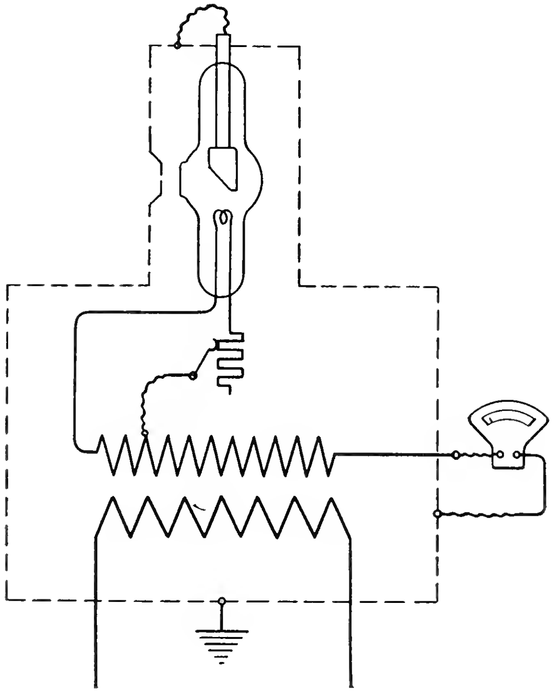


Fig. 12.

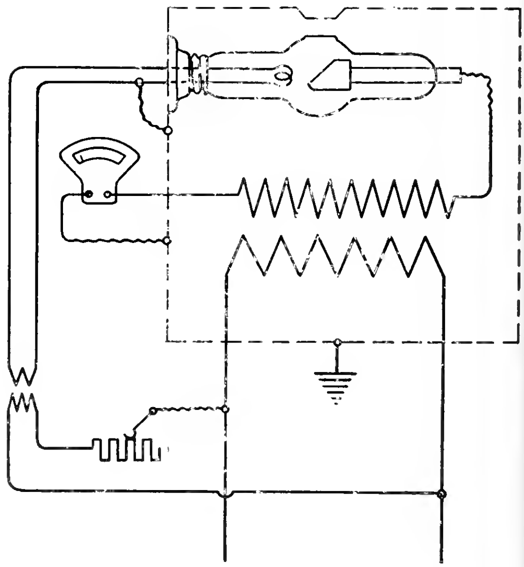


Fig. 13.

VII. POSSIBLE APPLICATIONS OF THE OIL-IMMERSED TYPE OF OUTFIT.

For radiographic work it seems thoroughly feasible to use such an outfit as that shown in Fig. 1. Higher power outfits of this same type should be equally satisfactory. One for 50 milliamperes and 60000 volts has been built. It is simply a larger edition of the one shown in Fig. 1 and weighs 75 pounds. In the field of radiography it is, perhaps, more especially in connection with high power work that the elimination of the high-tension risk will be most appreciated.

The application of such an outfit to general fluoroscopy is perhaps sufficiently obvious. It will be seen that when used under the table it greatly extends the allowable tube travel.

For fluoroscopic control in the reduction of fractures or any other surgical work, the oil-immersed type of outfit seems especially indicated, for it eliminates the electrical danger to the surgeon and his assistants, as well as doing away with the fire hazard attendant upon the use of high tension electricity in the presence of ether vapor. It can furthermore be used under the surgeon's operating table without the need of any precautions to keep blood and water off of it.

In therapy the oil-immersed type of outfit seems to offer special advantages. Aside from the general advantages, which will be summed up in the next section, it should help in work under the arm and in the treatment of body cavities. For the *x*-ray tube could be placed in a small cylindrical side arm leading off from the main transformer tank, as in Fig. 11 for example. This metal side-arm is connected to earth and could be

water-cooled. It could then safely be brought into contact with the patient. In this way, it would be possible to bring the focal spot of the tube to within a very short distance of the skin.

In experimental therapy, the system should make it possible to use, in a room of ordinary size, the highest voltage for which an x-ray tube can be developed.

VIII. ADVANTAGES OF THE OIL-IMMERSED SYSTEM.

The main advantages derivable from such a system are the following:

(a) Eliminates all danger of electric shock to patient or operator.

(b) Eliminates all corona discharges with attendant noise and odor.

(c) Eliminates fire-risk in presence of ether vapor.

(d) Makes it easy to get any desired amount of x-ray protection, for, if necessary, the tank itself can be lined with metallic lead.

(e) Makes practicable, even in small rooms, the use of as high a voltage as that for which an x-ray tube can be developed.

(f) Disposes of all light emitted by tube, which is a convenience in fluoroscopy.

(g) Makes it possible to bring the focal spot much nearer to the patient than is ordinarily practicable. This might be useful in certain therapeutic applications.

(h) Makes tube mechanically stronger by permitting use of shorter arms and a shorter anode rod.

(i) Gives greater heat conduction from focal spot to outer end of anode rod, by shortening the distance the heat has to travel.

(j) Assists in removal of heat from outer end of anode rod, as oil is a more effective cooling medium than air.

(k) Permits of safe and convenient use of tap water for cooling of oil or anode.

(l) Reduces danger of tube breakage by putting tube in a good damping medium (oil) and inside of a metal container. It furthermore eliminates all handling of the tube.

(m) Eliminates effect of humidity on performance of apparatus, a matter of considerable importance in moist climates. It also prevents the deposition on the tube of a conducting layer of salt spray at the seashore.

IX. A LIMITATION OF THE METHOD.

With such an outfit it is still necessary, in diagnostic work, that the focal spot of the tube shall be held stationary in space. As the weight of the tube and transformer is obviously much greater than that of the tube alone, the method necessitates a much more rigid, and hence larger and heavier, tube stand than would be required to support the tube alone.

In closing, the author wishes to acknowledge the assistance of Mr. L. E. Dempster and Mr. W. K. Kearsley, both of whom have actively contributed to the development work described in this paper.

DISCUSSION

Dr. Byron C. Darling.—I would like to ask Dr. Coolidge about the volatilization of tungsten in his tube. The smaller you get your tube, the smaller the total area of your circumference, and I am not enough of a mathematician to figure out the proportional area between a 6 inch bulb and a 7 inch bulb and a 1½ inch bulb, but it runs somewhere between 1 and 5. That would make your smaller tube last a much shorter time, which would make our bill five times what it is now for the same exposure time. It seems to me that the work that is being done to refine the apparatus is work well taken and time well spent. It occurs to me that a combination of the transformer and rotary switch and oil as one unit, and a tube in oil as another unit with Dr. Johnston's safety device, and some overhead high tension system that is safe, may be the ultimate solution for a man who is doing nothing but x-ray work in his office. The portable outfit, of course, is another matter. I have wondered why Dr. Coolidge did not put a radiator on his 7 inch bulb, all tungsten target tube, also the regular size copper and tungsten anode. It would seem to me that if it is an advantage to

get rid of heat it might be used in every size. The small button on the tungsten and copper target self-rectifying tube favors the heating of the copper surrounding, and if over-heated, the whole button falls out. The button is too small now.

Another question I would like to ask is how large a milliamperage capacity can be built with the suppressed wave type of apparatus mentioned.

Dr. W. D. Coolidge.—The size of an x-ray tube should, I think, be kept as small as is consistent with satisfactory operation, and for the following reasons:

(1) A small tube lends itself to more complete x-ray protection.

(2) For a given amount of protection, the small tube with its protecting envelope will weigh less and can therefore be used with smaller, lighter, and more convenient accessories.

(3) It is less liable to breakage in handling.

With conservative operation, there is no appreciable blackening of the bulb of even the smallest x-ray tubes.

It is quite feasible to have the x-ray tube in a separate tank of oil instead of putting it into the same tank with the transformer. The latter system has several advantages, however, which are not possessed by the former. For example, it puts the entire high tension circuit inside of a grounded metal inclosure.

As to the question of how large a capacity you can have in a system where the tube rectifies its own current: I am very sure that there is no limit. We have operated self-rectifying water-cooled tubes continuously for hours at a time, with as much as 5 and even 10 kilowatts of energy, and there appears to be nothing but the size of the focal spot and the size of the anode to set a limit to the allowable energy input.

Dr. Byron. C. Darling.—Transformer 100 kilowatts?

Dr. W. D. Coolidge.—Yes indeed. There is no trouble at all. It simply means a suitable design and the use of plenty of iron and copper.

RADIUM TREATMENT OF ENLARGED THYMUS GLANDS IN INFANTS

By ARTHUR C. HEUBLEIN, M.D.
Visiting Roentgenologist Hartford Hospital
HARTFORD, CONN.

UNTIL a short time ago inexplicable deaths in infants were in many instances erroneously attributed to a variety of causes, such as status lymphaticus (exclusive of status thymicus), foreign body in the throat, suffocation by the mother during sleep, or having a cat suck its breath.

In our present knowledge the above named causes of sudden death are now known to be due, in the majority of cases, to a pathological overgrowth of the thymus gland. According to Sajous,[1] in most instances of thymic death, the victim is a child found dead in bed, doubtless as a result of asphyxia due to tracheal stenosis, laryngeal spasm, or cardiac paralysis with an enlarged thymus found at autopsy, as sole evidence. Such cases may be the source of unwarranted accusations of criminal suffocation and an autopsy should always be performed if possible.

This gland normally occupies the anterior and upper part of the mediastinum, is encased in a rigid structure, the thoracic wall, and when enlarged presses on the trachea, the recurrent laryngeal and vagus nerves, the great vessels of the upper thorax and lower cervical region, and the right auricle.

Directly or indirectly, this overgrowth is the cause of sudden death in a great many infants. Unfortunately enlargement of the thymus gland has been, and continues to be to-day frequently overlooked. Although the patient may have no gross symptoms of thymic enlargement it may exist, and if unrecognized is a menace to life. Many infants die yearly as a result of heart shock during anesthesia. Before submitting an infant to an operative procedure demanding a general anesthetic, the previous history, and a thorough chest examination should be obtained, and in all suspicious cases, roentgenographs made.

Prior to the period when roentgen treatment of the disease became a recognized entity, benzoin and the croup kettle were freely used, the mother becoming expert in the technique of artificial respiration, and the attending physician calling at frequent intervals to see if the infant were still alive. Thanks to the ever increasing alertness of the pediatrician, and to the development of the *x*-ray as a diagnostic agent, there should be no excuse for this condition escaping recognition. Unfortunately it still does except in a few medical centers where this disease is looked for as a matter of routine. Its prevalence is well illustrated by Friedlander,[2] who states that in Dr. Benjamin's Out-Patient Clinic in Cincinnati, of all the new patients admitted during the year, namely 225, 8.4 per cent were indisputable thymus cases.

There are many theories as to the etiology of thymic enlargement, but as yet no definite cause can be assigned. Pathologists tell us that it is a simple hyperplasia of all the elements of the gland.

In November, 1919, Edward A. Park and Roy D. McClure[3] of Baltimore reported a series of experiments on dogs. The conclusions of their exhaustive investigation are as follows:

1. The thymus gland is not essential to life in the dog.

2. Extirpation of the thymus produces no detectable alteration in the hair, teeth, contour of the body, muscular development, strength, activity or intelligence of the experimental animal.

3. Extirpation of the thymus probably does not influence growth or development. The possibility that it may cause retardation in development and delayed closure of the epiphyses, however, cannot be excluded absolutely.

4. Extirpation of the thymus probably produces no alterations in the organs of internal secretion. It is possible that it produces well-marked changes in the organs of internal secretion in the period immediately

FIG. 1. ILLUSTRATING BULGING OF ANTERIOR AND UPPER CHEST AND ECZEMA WHICH FREQUENTLY ACCOMPANIES THIS DISEASE.

following thymectomy which was not covered in their experiments.

Briefly, the symptoms of enlarged thymus may be divided into two groups, general and local. The former are muscular hypotonus, eczema, lack of resistance to acute infectious diseases, and convulsions. The latter consist of those symptoms arising from interference with respiration and deglutition due to the mechanical effect of the enlarged gland. They vary from a slight cough to profound dyspnea with or without associated cyanosis. The respirations are usually audible, and when dyspnea is severe there may be a distinct inspiratory "crow." These symptoms may be precipitated or aggravated by exertion, such as crying, feeding, fright, or by extension of the neck.

The diagnosis is made by the history, the physical examination, and the final and most accurate evidence, the roentgenogram. Inspection often shows a flabby child with retraction of the abdomen and intercostal muscles, with a bulging of the upper and anterior chest. Light percussion reveals an area of dullness to either side and continuous with the dullness over the sternum. It is usually more pronounced on the left side.

The roentgenograms show a shadow overlying and continuous with the shadow of the heart and great vessels. Its margins are usually convex, more prominent on the left than the right side, and extending upward beneath the clavicles, blending with the tissues of the neck.

To date I have treated 41 cases, 34 of which Dr. Brayton and I reported in the December number of the *Boston Medical and Surgical Journal*.[4] In this series a constant technique was observed in producing the roentgenographs. The patient was placed flat on the back, and a series of plates were made at a constant target plate distance until a plate was obtained which showed no distortion. Speed is an important factor, and of late I have found the double screen technique the most satisfactory.

A little over two years ago I was called in consultation by Dr. Howard W. Brayton, assistant pediatrician to the Hartford Hos-

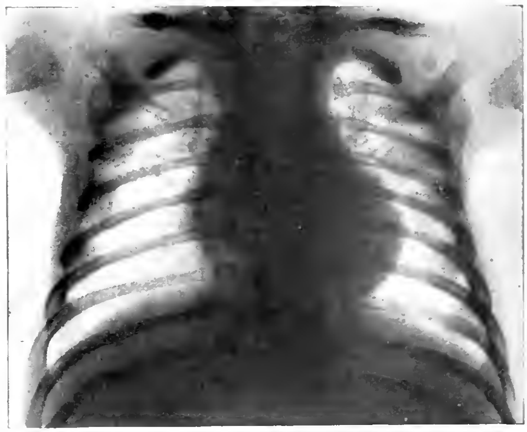


FIG. 2. NORMAL THYMUS SHADOW.

pital, to see an infant practically moribund from the effects of an enlarged thymus gland. The patient was markedly cyanosed and gasping for breath. An *x*-ray examina-

tion showed a thymus filling nearly half the chest. Although roentgen therapy was recommended, as up to this time it had proved to be the only effective method of treatment, yet partly from an experimental standpoint, and also in view of the fact that with radium I had observed a more rapid diminution in the size of other pathological overgrowths, I departed from the accepted method of treatment, and used radium.

The result was so eminently satisfactory in this case that I have treated all other cases in a similar manner. The technique which was followed was cross-firing with 100 milligrams of radium element, filtered through 0.3 mm. silver, at a half-inch skin tube distance through four portals of entry, the tube being placed over the anterior aspect of the chest directly over the thymus gland. The tube is left two hours in each position, which makes a total dosage of 800 milligram hours. As time is such an import-

FIG. 3. CASE I. BEFORE TREATMENT. TWO WEEKS AFTER TEN WEEKS AFTER

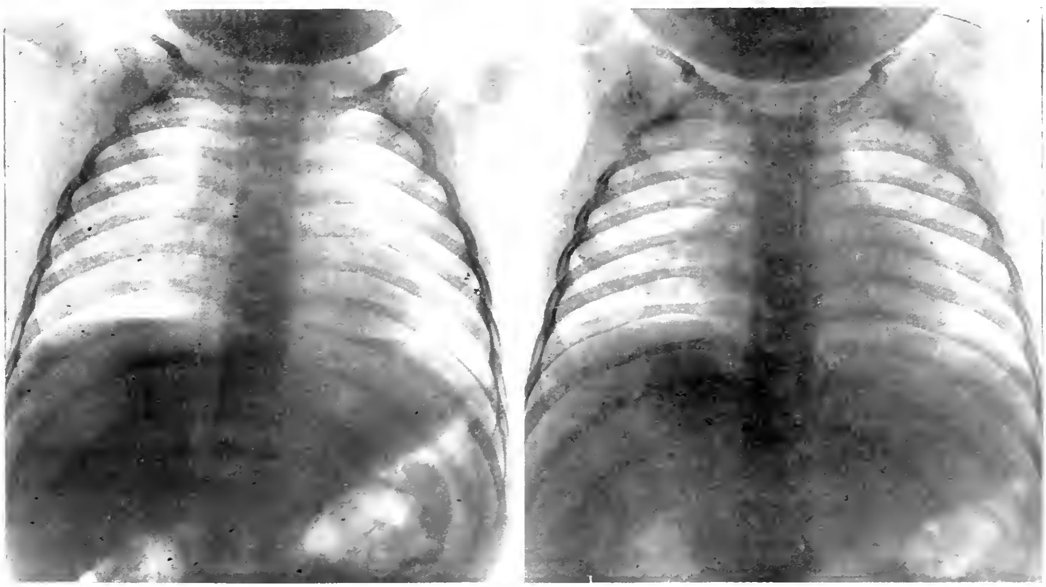


FIG. 4. CASE 2. BEFORE TREATMENT. ONE WEEK LATER.

ant factor in these serious cases I have now substituted 200 milligrams with half the time of exposure.

In my series of 41 cases the dosage administrated seemed to be sufficient to cure large as well as small thymic overgrowths in one application, and as now it is conclusively proven that the thymus has no function after birth, we need not fear over-treatment. None of my cases have shown any tendency to regeneration of the gland. Possibly these results could have been obtained by a single intensive x-ray treatment, but in reviewing the literature I find no such results reported.

In conclusion, I want to emphasize the following: Thymic enlargement is a common disease in infants. Radium as well as the roentgen ray is specific in its effect, but radium has the following advantages: It is portable; it gives the desired result in one treatment; it is simple, thus eliminating the dangerous element of fright, as infants resist the fixation necessary in roentgen ray treatment, and this very fixation may be the exciting cause of thymic crisis and death; radium is a safe procedure, as the skin tube distance never varies in the most refractory child.

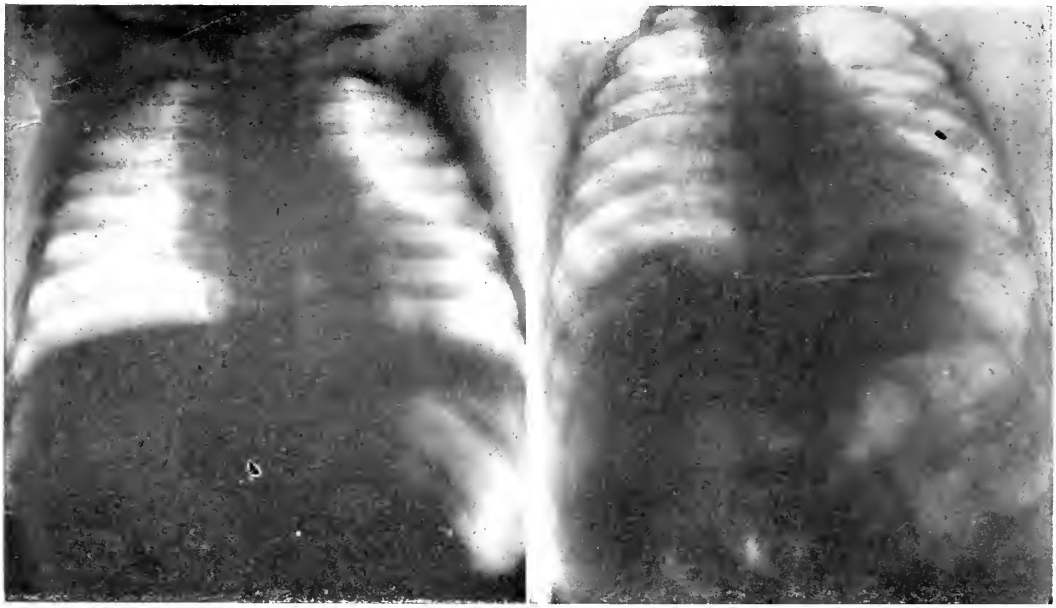


Fig. 5. Case 3. Before Treatment. One Week After.

Case 1. A male infant, 12 pounds in weight, was seen one hour after birth. The labor had been easy but with the first cry the obstetrician had noticed that the child's breathing was decidedly abnormal. The patient presented the most unusual appearance; the skin, lips and nails were intensely cyanotic and the inspiratory stridor was distinctly audible in the adjoining room, while the epigastric retraction was equal to that accompanying the severest forms of laryngeal diphtheria. Percussion and x-ray both indicated the presence of a thymus filling nearly one-half of the chest cavity, while inspection, palpation, and x-ray all revealed the presence of an enormous thyroid occupying the entire front of the neck as far back as the lobes of the ears. Radium was applied and within twenty-four hours the baby showed improvement and within forty-eight hours there was decided improvement, which continued until, at the end of a week he was nearly normal in appearance. It was interesting to note that the thyroid disappeared coincidently with the shrinkage of the thymus. The child was still perfectly well fifteen months after discharge.

Case 2. Male, fourteen months of age.

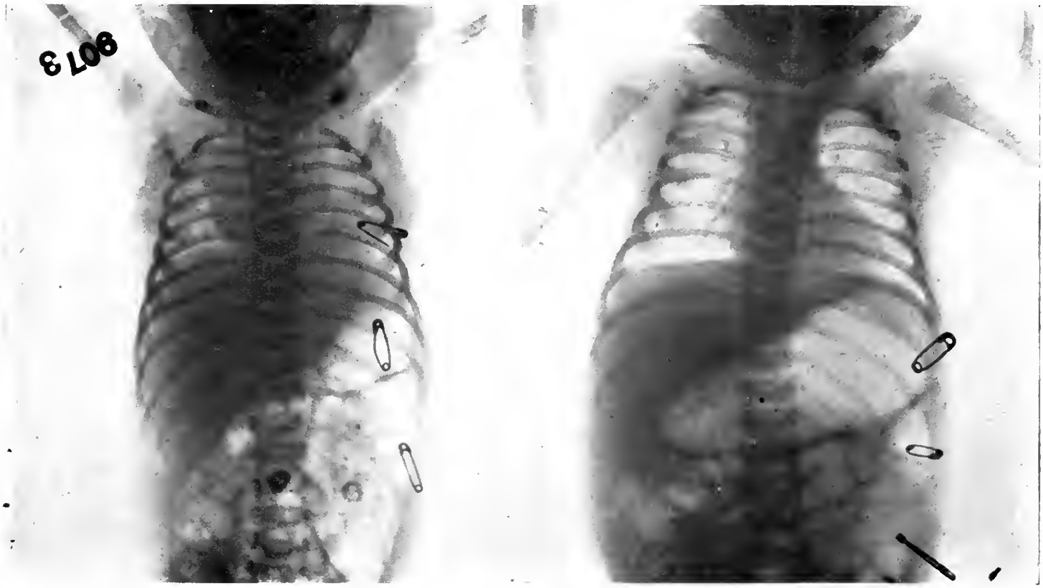


Fig. 6. Case 4. Before Treatment. One Month Later.

with a history of eczema, weakness and convulsions from birth. On close questioning these convulsive seizures were found to consist of the following sequence of events: sudden asphyxia, cyanosis, retraction of the neck, general clonic contractions, syncopy followed by exhaustion. Examination showed a flabby, eczematous child with bulging of the upper chest and well defined thymic dullness. *X*-ray corroborated these findings. Radium was applied. The child had no more convulsions and one week later the roentgenogram showed a normal thymic area.

Case 3. A female of eleven months who had always breathed "as though she had a cold." Frequent attacks of choking and cyanosis, particularly at time of feeding. *X*-ray confirmed the percussion findings of enlarged thymus. One week after treatment the child was perfectly well.

Case 4. Female infant, weighing at birth 10 pounds. Mother primipara with contracted pelvis, requiring extremely difficult high forceps operation. Child's head very much lacerated and left clavicle fractured. Because of these injuries the obstetrician attributed the peculiar breathing of the infant to cerebral pressure. The baby was cyanotic and cried with a peculiar crowing inspiration. Stridor and retraction were present, particularly during nursing and when head was extended. Three days after birth the infant was seen by Dr. Brayton, who found increased thymic dullness and referred the case to me. Five days after treatment the child was free from symptoms and has remained so to date.

References

1. Sajous. "Analytic Cyclopedia of Practical Medicine."
2. *Am. J. Dis. Child.*, July, 1917.
3. *Am. J. Dis. Child.*, November, 1919.
4. *Boston M. & S. J.*, Dec. 25, 1919.

TESTS OF X-RAY INTENSIFYING SCREENS

By R. B. WILSEY
Research Laboratory, Eastman Kodak Co.
ROCHESTER, N. Y.

IN SEEKING to determine the properties of various *x*-ray intensifying screens, some interesting facts were brought out. Some of the characteristics of intensifying screens were already known from practical experience, and the tests served merely to demonstrate them more clearly. Other peculiarities were found which had not been previously suspected.

Obviously to get the best results in intensifying screen work, it is necessary to know the characteristics of intensifying screens in general, and especially the qualities of the particular screen being used. One should know under what conditions a screen may be used with advantage, and under what conditions a screen should not be used. It is also desirable to be able to compare readily the qualities and merits of various screens.

The most important intensifying screen characteristics, from a practical standpoint, are speed (intensifying factor), definition, and graininess. These are not difficult to test practically. In the hope that our experience may be of use to other workers in radiography, we shall attempt to describe the methods we have used in testing screens, and the character of the results obtained.

The intensifying factors of the screens were determined by making radiographs of several subjects in the usual way, the intensifying factor being taken as the ratio of the exposure without screen to the exposure with screen to produce the same average density of negative. A standard exposure for each subject was given the film, loaded in the ordinary card board film holder. Several different exposures were made with the same subject upon the film with intensifying screens in an aluminum cassette. All the films were given the same standard development in Elon-hydroquinone developer. The resulting negatives were carefully compared by visual inspection to see which one made with screen had an average density equal to the one made without screen.

The ratio of the exposures of these two negatives gave the intensifying factor. In case a screened negative which matched the unscreened negative was not obtained in the first trial, the experiment was repeated nutil a match was obtained. Radiographs were made on four kinds of subjects, a hand, a spine, a wax knee, and a dry skull. The "wax knee" is a joint from a human skeleton, encased in wax which has been molded to the form of a human knee. This wax knee is a very satisfactory test object for radiographic purposes.

For all tests the Coolidge radiator-type tube was running at a 5-inch spark gap, 10 milliamperes, with a target film distance of 20 inches. The photographic material used was "Dupli-Tized" *x*-ray film. The exposures were timed by means of a sensitometer timing mechanism, with which exposures as short as 1/6 of a second could be obtained with quite satisfactory accuracy. The results obtained with several varieties of intensifying screens are given in Table 1, the different types of screen being indicated by letters.

TABLE 1

	Intensifying Factor for			
Screen	*Dry Skull*	*Wax Knee*	*Hand*	*Spine*
(A) Double	4.0	3.25	4.0	3
(A) Single	2.75	2.25	2.5	2
(B) Double	4.0	3.25	—	—
(B) Single	5.0	4.5	5	4
(A) Thin Front with (B) Thick Back	4.7	4.5	—	—

Exposure without Screens

Dry Skull	*Wax Knee*	*Hand*	*Spine*
1⅜ sec.	1½ sec.	1¼ sec.	10 sec.

1⅜ sec. 1½ sec. 1¼ sec. 10 sec.

To obtain the exposure with any screen or combination of screens, divide these exposures by the intensifying factor.

Fairly strong negatives were obtained in these tests. Some workers prefer negatives of lighter density. Since intensifying screens in some cases increase the contrast of the negatives, the intensifying factors will then be smaller for lighter density of negative.

The factors for the hand and spine were not obtained for all the screens. The factors obtained with the wax knee appear typical of those obtained for the deeper parts of the human body. The results of the skull and wax knee are considered more precise than the others, since we were able to obtain more checks upon them.

With some screens, the double combination is faster than the single screen, as is shown by screen *A*; other screens are faster as single screens, as in the case of screen *B*. In each of the *A* and *B* double combinations, the front screen is thinner than the back screen. The *A* front screen is shown in Table 1 to be more effective than the *B* front screen when used in combination with the *B* back screen; but when the back screen is omitted, using each screen as a single front screen, the *B* front screen was found to be the faster of the two. This shows that the *B* front screen had the greater absorption and allowed less radiation through to excite fluorescence in the back screen. A front screen of such a combination should have low absorption for *x*-rays as well as a high intensity of fluorescence.

Since the *A* front screen increases the speed of the *A* back screen by about 50 per cent or more, it might be expected to increase the speed of the *B* single screen by a similar amount. However, such is not the case; the speed of the *A* front with the *B* back screen is but little different from that of the single *B* screen. This shows that the *A* and *B* back screens are differently affected by the change in the quality and intensity of the incident radiation produced by interposing the *A* front screen.

The thin front screen of a double combination usually makes nearly as fast a back screen as the regular thick back screen, and hence may be used as a back screen with no great loss in effectiveness.

All the screens gave greater contrast when used as a double than when used as a single screen. This explains the "snappy" and "brilliant" appearance of double screen radiographs. The low densities have been given less intensification than the higher densities, and are actually clearer than the same areas would be in the radiograph made without screens. The general fog due to scattered radiation is likewise less intensified in the lighter densities, and therefore shows up less than in a radiograph made without screens.

The intensifying factor depends to some extent upon the degree of development of the film; the image made by the intensifying screen lies near the surface of the emulsion, while the *x*-ray image penetrates the whole depth of the emulsion, and these two images develop at different rates. The standard development used in these experiments was 5 minutes in Elon-hydroquinone developer, in a tank, at 65 degrees Fahrenheit.

Table 1 shows that for each screen the intensifying factor varies with the part radiographed; this effect was carefully checked. The values for the spine and the wax knee agree very well, and probably represent quite closely the values that would be obtained for any of the deeper parts of the body. Since intensifying screens are ordinarily used only for radiographing deeper parts, the variation of intensifying factor with the part radiographed need scarcely be taken into account in practical radiography.

The possibility of using the *x*-ray sensitometer to measure the efficiency of an intensifying screen has been pointed out by Hodgson.[1]

Such a method admits of higher precision than practical tests, but the necessary conditions to be observed in a sensitometric method require a greater knowledge of the fundamental characteristics of intensifying screens than we have at present, if sensitometric tests of screens are to be of value for practical radiography. The con-

[1] Hodgson, M. B. The Sensitometry of Roentgenographic Materials. *Am. J. Roentgenol.* Dec. 1917. pp. 610-17.

ditions in sensitometry are usually different from the conditions of radiography. In sensitometric tests, a lower intensity of radiation is employed than is usual in radiography. In the sensitometer, the various densities are produced by the same intensity and quality of radiation acting for different times, while a radiograph is made by various intensities and qualities of radiation all acting for the same time. However, if the intensifying effect of a screen does not vary with the intensity and quality of the incident radiation, then sensitometric tests of screens should give the same results as practical tests.

Experiments were made to determine the validity of the ordinary sensitometric method of measuring the efficiency of intensifying screens.

In the *x*-ray sensitometer, one half of the film was backed by the intensifying screen, or in the case of a double screen, sandwiched between the two screens, the other half of the film being exposed without screens. Both halves of the film received the same series of exposures, which were accurately controlled by the sensitometer timing mechanism. After exposure, the film was given the standard development in an Elon-hydroquinone developer, and the resulting densities were measured. For each film, two sensitometric curves were plotted, one for the strip made with intensifying screens, and one for the strip produced by the *x*-rays alone. From these curves could be determined the exposures required to produce any given density either with or without the screen. The ratio of the exposure without screen to the exposure producing the same density with screen is the intensifying factor.

A large number of sensitometer tests were made with various screens and upon several photographic emulsions. Often the results obtained were quite different from those obtained with the same screen and emulsion using a live subject under the conditions ordinarily used in practical radiography. It was evident that the sensitometric method could not be relied upon to give correct intensifying factors. The result of the sensitometric tests of screens *A* and *B* are shown in Table II. The intensifying factors determined by the sensitometer are given for densities of 1.0, 1.5 and 2.0. In these tests the tube was run at 5-inch spark gap, 1 milliampere, at a distance of 128 centimeters from the film. Table III gives the results when the same radiation was filtered by 1.7 millimeters thickness of aluminum. These values should be compared with the intensifying factors for the same screens determined by making radiographs of various subjects as given in Table I. "Dupli-Tized" *x*-ray film was used in these tests, all the films receiving the same standard development as the practical tests reported in Table I.

TABLE II. SENSITOMETRIC RESULTS.

Screen	INTENSIFYING FACTOR FOR DENSITY OF 1.0	1.5	2.0
(A) Single Screen	1.75	1.57	1.48
(A) Double Screen	1.87	1.89	1.83
(B) Single Screen	1.79	1.64	1.52

TABLE III. SENSITOMETRIC RESULTS WHEN ALUMINUM FILTER IS USED

Screen	INTENSIFYING FACTOR FOR DENSITY OF 1.0	1.5	2.0
(A) Single	2.66	2.47	2.35
(A) Double	2.48	2.36	2.30
(B) Single	4.62	4.00	3.38

Upon comparison with Table I, the discrepancies are quite apparent between the sensitometric results and those obtained by making radiographs under practical conditions. Furthermore, for unfiltered rays, the sensitometer gives only a slightly higher factor for the *A* double than for the *A* single screen, and where an aluminum filter was used, the double screen was less effective than the single screen. In practice, it is found that the speed of the *A* double combination is faster than the *A* single screen by 50 to 75 per cent.

It has been noted by other observers that the intensifying factor of a double screen increases with *x*-ray intensity. To show this effect sensitometric tests were made in which the spark gap (5 inches) and current (1

milliampere) were kept constant, and the intensity varied by changing the target-film distance. The exposure times were varied inversely as the x-ray intensity, so that every sensitometer strip received the same series of x-ray exposures. The intensifying factors obtained in this way are given for various target-film distances in Table IV.

TABLE IV

	Intensity	INTENSIFYING FACTOR FOR DENSITY OF 1.0	1.5	2.0
Distance = D = 130.8 cm.	1	1.59	1.62	1.63
Distance = $\frac{D}{\sqrt{2}}$ = 92.5 cm.	2	1.88	1.88	1.84
Distance = $\frac{D}{2}$ = 65.4 cm.	4	2.19	2.29	2.37

The same effect was tested by making radiographs of the wax knee with and without a double screen, using currents varying from 0.5 milliampere to 20 milliamperes, with target-film distance of 20 inches, and spark gap of 5 inches. In this experiment a constant intensifying factor was assumed, so that at every value of the tube current, the ratio of the exposures with screens to the exposures without screens was the same. At 0.5 milliampere the screened negative was less dense than the unscreened negative, showing that the assumed intensifying factor was too high; at 20 milliamperes, the screened negative was denser than the unscreened negative, showing the assumed factor to be too low. Thus the intensifying factor of a double screen was found to increase with increasing x-ray intensity. This effect, in part at least, accounts for the fact that higher contrast is secured with double intensifying screens than without screens; the higher densities of the negative are produced by the higher x-ray intensities, and receive relatively greater intensification than the lower densities. No doubt the agreement between sensitometric and practical tests of screens would be closer if higher x-ray intensities were used in the sensitometric tests.

The sensitometric method of measuring intensifying screens efficiently is essentially the same as the "step" method, described by Morrison.[2] In the sensitometer, a series of exposures is given to the screened portion of the film as well as to the unscreened portion; thus the intensifying factor can be determined for any density within the range of densities common to both halves of the film. In the step method as ordinarily used, but one exposure is given with the intensifying screen. The x-ray intensities generally used with the step method are higher than those of the present sensitometric tests and therefore should give results more nearly approaching those of practical tests. Our present form of sensitometer does not operate rapidly enough to make it possible to use as high x-ray intensities as are used in radiographic work; the construction of a high intensity x-ray sensitometer for use with a pulsating source of high potential offers considerable difficulty.

From the above experiments, it is concluded that at present the most reliable method of determining intensifying factors is by practical trial, using the kind of subject, spark gap, tube current, target-film distance and the photographic material with which the screen is to be regularly used.

The graininess of intensifying screens was estimated by a flash test, sufficient exposure being given to produce a half tone density with standard development of the film. It was necessary to secure firm contact between the film and intensifying screens; in case any of the screens were rather stiff, several thicknesses of blotter were loaded in the cassette behind the screen to increase the pressure. After development, the films were examined with a magnifier for graininess; where the graininess was at all bad, it was easily evident to the naked eye. Fig. 1 shows some photomicrographs of such tests for graininess.

Comparative tests of the primary definition given by intensifying screens were made by radiographing copper gauze

[2] Morrison, R. T. A Practical Method for Testing the Efficiency of an Intensifying Screen. *Am. J. Roentgenol.* Sept. 1919, p. 458.

meshes, such as are used by chemists. Primary definition is largely a function of the inherent screen graininess. Two such meshes were used, one having 67 spaces per inch and the other 200 per inch. A piece

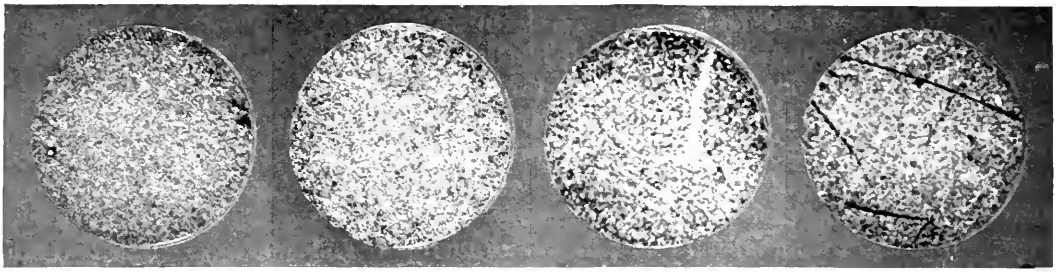
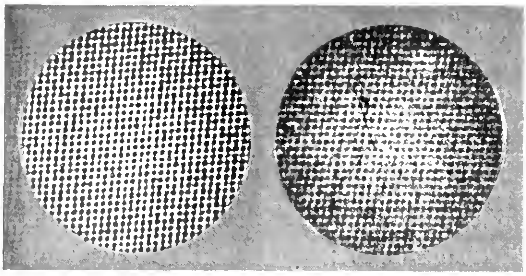
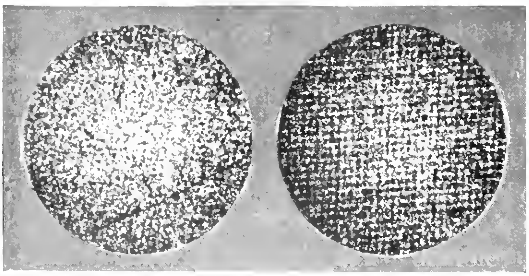


Fig. 1. Showing Graininess of X-Ray Intensifying Screens; Magnification, 9 Diameters.



A B



C D

Fig 2. Primary Screen Definition Tests, with Wire Gauge of 200 Mesh per inch; no Scattering Medium between Screen and Tube. Magnification, 9 Diameters. A. X-Ray Film without Screen. B. Single Screen. C. Double Screen. D. Double Screen.

of each gauze was cut out to about one inch square and mounted in cardboard to keep it flat; for the test, it was laid upon the cassette or the cardboard holder containing the film. Precautions were taken to secure good contact between the intensifying screens and the film. The fine focus Coolidge tube was used, at a distance of 50 inches from the film, with 5-inch spark gap and 10 milliamperes. The exposures varied from ½ second to 1¼ seconds, according to the speed of the screens, and were adjusted to give a half tone density upon the film. The resulting negatives were examined with a small magnifier. Individual screens were found to vary considerably in excellence of definition. Photomicrographs of some of these tests are shown in Fig. 2. The definition of "Dupli-Tized" X-Ray film without screen is by this test markedly superior to the best screen definition. It should be borne in mind, however, that no scattering medium was interposed between tube and film. The 200-mesh gauze is well suited to such definition tests; the best intensifying screens show the meshes quite distinctly, while with the poorest screens, the meshes can scarcely be distinguished. These tests showed that somewhat better definition is obtained with a single screen than by the double combination; all the single screens except one were found better than any double screen combination. This factor of definition is being investigated further and the writer hopes to present at some future time the results of tests showing the efficiency—from point of definition—of various exposure techniques when scattering material is interposed between tube and film, thus approximating conditions of actual practice.

Further tests were made for variations in definition over different parts of the cassette, due to lack of contact between the screens and the film at some places. The method employed by Dr. Coolidge was used; a piece of copper gauze (67 meshes per

inch) covering the whole area of the cassette was radiographed. As in the previous tests, the fine focus tube was used at a distance of 50 inches. A cassette whose cover was held shut by a single strong spring pivoted at the center, was first used. A pair of moderately flexible screens were used in this cassette and the test showed the definition to be quite uniform over all parts except the corners, where the definition shaded off slightly. The definition at the corners was not improved by packing blotters in the cassette. The difficulty, therefore, was not lack of pressure, but uneven distribution of the pressure. The same pair of screens were tried in another cassette, whose cover was held shut by two rather weak springs. Better uniformity of definition was found in this case; the pressure was not as strong, but it was more evenly distributed.

Another pair of intensifying screens were also tried; these screens were very stiff and had a tendency to curl. The result was that very poor definition was obtained; improvement was effected by packing blotters in the cassette, but even then it was not satisfactory; in the case of the single spring cassette, the definition was fair in the central area but very poor near the edges and corners. The single screen was more easily held flat and gave good definition over the central area, shading off toward the ends and corners. To secure good uniformity of definition, it is necessary to have the screens fairly flexible; or, if they are stiff, they must remain flat with no tendency to curl. The cover of the cassette should be as rigid as possible, and the springs arranged to give an even distribution of the pressure.

SUMMARY

The writer believes that the following specifications should be considered in deciding upon the materials for use in screen technique:

1. Screens.—They should be flexible, of uniform multiplying factor from screen to screen, free from noticeable primary graininess and of good definition. The American screens generally used in this country as a rule fulfill most of these conditions.

2. Cassettes.—They should give good contact all over the surface of the film or plate, as shown by wire screen test; they should be free from material which will shed lint and should have no tendency to accumulate aluminum or lacquer dust.

In order further to adapt films and plates for screen technique, the writer wishes to report that experiments are being continued toward this end. In view of the fact, however, that the present photographic materials are rather well adapted to the screen fluorescence a radical change is not to be expected without changing the material in the screen. It does not seem probable that any great change can be expected in this direction either.

In conclusion the desirability of either single screen or double screen technique seems to be a question for the decision of the individual. With the single screen a multiplying factor of five can be had, the definition is good, but there is no appreciable increase in contrast. With the double screen a factor of from three to five can be obtained, there is a slight loss in definition, but there is increased contrast and noticeable freedom from recording of scattered radiation. Where straight reduction of exposure time is all that is required, the single screen technique will probably be desirable. It will, however, be for the individual roentgenologist to decide whether the increased contrast and freedom from scattered radiation with the double screen method are worth the initial cost of the screens. Decisive tests of either method are comparatively simple to make. It is regretted that it is impossible to reproduce the negatives made in the foregoing investigation so that they would correctly illustrate the points brought out.

In conclusion the writer wishes to express his indebtedness to Mr. M. B. Hodgson for suggesting that these tests be made, and for helpful advice during the progress of the experiments. Mr. A. P. H. Trivelli very kindly made the photomicrographs of the definition and graininess tests.

RADIUM IN THE TREATMENT OF CARCINOMA OF THE CERVIX AND UTERUS

By RUSSELL H. BOGGS, M.D.

Roentgenologist, Allegheny General Hospital; Dermatologist and Roentgenologist, Columbia and Pittsburgh Hospitals

PITTSBURGH, PA.

A LARGE number of cases of carcinoma of the cervix and uterus in all stages have been treated by radium during the past five or six years, and the results obtained have been sufficiently good, so that the medical profession has accepted this method of treatment not only as a palliating agent, but as a curative measure. Its status is such now that many consider it one of the most valuable therapeutic agents we possess. As was to be expected, this method is drawing into the field many physicians without adequate training, and the poor results which follow the poor technique are bound to react; but this reaction will not be against the medium used, but rather against the user.

Unfortunately most gynecologists using radium are more familiar with carcinoma from the operative standpoint than the radiotherapeutic. It is just as necessary to develop a radium technic as a surgical, and for some time to come the best end results are bound to be produced by those who have studied every detail, checked up a large number of cases and compared them with a large series of cases treated by others. A great many cases have been treated by different physicians and surgeons, and since their method of applying the radium varies considerably, it is natural to expect that their end results, as well as the amount of palliation, vary considerably.

Until lately, only the hopelessly inoperable and recurrent cases were referred for radium treatment, but now we are getting border-line and more favorable cases. We should be careful not to make enthusiastic and unwarranted statements. Whatever the method of treatment of cancer, conservative statements and rather radical methods of treatment are advisable. Can a gynecologist give a prognosis from clinical history, pelvic examination, examination of tissues at the time of operation, or a pathological report? No! Then why should extravagant statements or promises be made in any given case?

Bailey states: "Experience has taught that removing the local lesion is not the most important factor in the operable case, and that in order to increase the number of cures our efforts must be directed towards the involvement, often impalpable and invisible, of the lymphatic tissue throughout the lower part of the pelvis. Hysterectomy, with the most extensive type of dissection and removal of the tissues of the parametrium, has been the effort in this direction, and although it is a procedure that carries a high primary mortality, it is a move in the right direction, and has been until now the only hope for these sufferers. Nevertheless the five-year cure period shows a discouragingly low percentage alive, and from a microscopical standpoint it must be admitted that even the boldest operator can hardly hope to remove all the lymphatic tissues about the base of the bladder, in the parametrium befond the uterus, or in the base of the uterosacral ligaments."

Then, since radium can destroy cancer cells which cannot be reached with the knife, it is necessary to develop the most efficient technic possible. Most of those who have treated a large number agree with Janeway, when he says: "Our present evidence indicates that radium destroys the disease at a greater distance than the knife is capable of removing it, and does this with no risk or inconvenience to the patient." Kelly states: "Recent studies have shown that in from thirty to fifty per cent of operative

cases of cancer of the uterine cervix, the disease has formed metastases into the pelvic nodes." Similar statements have been made by other surgeons. Since it is the general opinion that the removal of the pelvic lymph-nodes has very little curative value, we should develop an efficient method for radiating the lymphatics. Unfortunately we are unable by any clinical test to determine whether or not there is an extension into the pelvic lymphatics. Therefore, the only safe way to do is to ray the pelvic glands in all cases, regardless of the stage of the disease.

Recent studies have shown that there is no dependable relation between the size of the primary growth and the presence or absence of metastases. It has been stated that in forty per cent of inoperable carcinoma of the cervix the pelvic nodes are free from metastases. This would account for brilliant results in moderately advanced cases by radical hysterectomy and from local radium treatment with an even inefficient radiation to the pelvic lymphatics, because even local radiation properly given appears to destroy cancer cells at a greater distance than can be removed by a simple hysterectomy. Really, in any given case, we are unable to determine by any method of diagnosis whether the metastases have occurred in the glands or not, and the patient should receive the most efficient radiation possible to the lymphatic glands in the pelvis.

It has been stated that about seven or eight per cent of the cases of carcinoma of the cervix applying for treatment are free from cancer after five years.

Uterine cancer which arises in the fundus grows slowly, and usually does not extend beyond the uterus until late in the course of the disease. Operative mortality is low, with a high percentage of cures. Cancer which arises from the cervix runs a more rapid course, early invading adjacent tissues, and hysterectomy for carcinoma of the cervix is attended with a higher mortality and a large percentage of recurrences.

Cancer of the cervix is divided histologically into the squamous-celled and the cylindrical-celled or adeno-carcinoma. The squamous-celled type is the most common, and the adeno-carcinomas are more malignant, are usually situated in the cervical canal and are not diagnosed early.

Hysterectomies have been performed following radium treatment. In a large percentage of the cases within four to six weeks after radium treatment no cancer cells were found in the cervix, but in some instances there were traces of malignancy in the broad ligaments. This is an important fact, and is worthy of a very careful consideration by the gynecologist as an ante-operative procedure even in early cases, because it has been long known that we are never able to say positively that the lymphatics or adjacent tissues have not metastiasized.

The same holds true here as in cancer in other parts of the body, namely, that cutting out the center of a cancerous lesion never retards the disease, but that it is safer to operate after cell proliferation has been checked. If we consider that an operable case is one in which there is no extension of the cancer cells beyond the cervix, then two things will be accomplished by ante-operative treatment—destroying cells entirely and checking cell division, and the formation of productive inflammation to be followed by fibrosis. The first effect is obtained in from two to four weeks, but the fibrous formation will not take place until from four to eight weeks. In many cases of cancer of the cervix during this time there is a disappearance of cancer cells in the cervix and even to a considerable depth. It has been stated that this has been accomplished by the actual cautery; but it should be remembered that radium will destroy cancer cells at a considerably greater distance than heat.

When radium is used as an ante-operative procedure, the operation should be performed within from four to eight weeks before marked fibrous formation has taken place. Nogier claims that cancer cells beyond the reach of the knife often lie latent until after the operation, and that the operation seems to arouse the cells, and is followed by

recurrence. He advocates treating the local lesion, but especially the lymphatic glands, which he claims are ordinarily invaded. He believes the scattered cancer cells lose their power of reproduction after radiation, and that if any embolism occurs following the operation the embolus is sterile, and that there is not the same chance of cancer extension in the cases which have had ante-operative treatment. Finally, he claims the evidence is overwhelmingly in favor of radiotherapy followed by excision, as the logical treatment for cancer.

The results by the Wertheim operation in favorable cases correspond with statements which have been made by various authorities, that is, the early involvement of the parametrium or the lymphatics at the time of the operation, according to different observers, varies from thirty to sixty per cent. This would lead us to believe that only cases in which really no glandular involvement whatever has taken place were cured by a Wertheim operation alone, and that proper local radium treatment, supplemented by sufficient cross-firing from radium packs or the *x*-rays from outside as ante-operative precedure would cure many more cases. Then we may ask the question, should those who do the most radical operation subject their patients to a high operative mortality without giving them all the benefit possible from radiation, or until a larger percentage of cures takes place than has been reported by even the boldest surgical operators?

It is neither the occasional brilliant results nor the failures that count in work of this kind, but it is the correct analyses of all cases with full histories and a careful follow-up record that will give us the real value of this procedure. Hall believes that if uterine hemorrhage cases had radium early enough, there would be a great decrease in the number of uterine cancer cases.

Cancer of the cervix may be divided clinically into four groups, namely:

1. Early cases, where the growth or ulceration is limited to a part of the cervix and does not extend into the vaginal walls. Even in these early cases recurrences take place, and even metastases into the glands may have occurred before the operation.

2. Where the process is more advanced, and clinically the involvement is still limited to the tissues of the uterus because the organ is freely movable. Cases of this class may include cauliflower growths, which protrude from the cervix and often fill the greater part of the vagina. Even in these cases the cancer cells may not have reached the pelvic lymphatics. This is a class which will derive great benefit from ante-operative treatment, and by such procedure the end results should be better.

3. Where the disease is further advanced and the carcinoma extends into the vaginal wall. There is slight fixation of the uterus, but clinically there is not extensive involvement of the broad ligaments. If there is no glandular involvement, which we can never determine clinically (although, as before stated, the glands are often free in cases of this class), rather a high percentage may be clinically cured by radium treatment. Time alone will tell whether or not we should depend upon radium alone, even if we have obtained brilliant results by radium in a number of instances.

4. Cases of carcinoma of the cervix with marked fixation of the uterus, the disease extending into one or both broad ligaments with involvement of the vaginal wall, and a greater part of the cervix destroyed.

In many of these cases glandular involvement has taken place, and in some instances metastases have extended into the liver. These cases often will derive a great deal of benefit from radium, and a local or clinical cure frequently will take place. But even if metastases have been extensive the patient may remain free from cancer symptoms from one to three or more years. A cure might be effected, but with our present method of treatment we always expect the patient to die from metastases rather than look for a permanent cure.

When it is considered that about one-third of the cases of cancer of the cervix that

receive no treatment die within a year without an operation, that a large percentage of the remainder die within two years from the first manifestation of the disease, and that very few live three years, it is apparent that the amount of palliation and prolongation of life from radium treatment (and the fact that many of them die of internal metastases without return of the local symptoms), mean much to the patient. To-day radium is indicated as a palliative measure for hopeless inoperable and recurrent cases as an ante-operative precedure, and for prophylaxis after surgical removal. Lately radium is being used by some physicians for primary cases in carcinoma of the cervix when the disease extends into the cervical canal, because nearly all of those cases are followed by recurrence even in the early cases after operation. The malignant process in these cases will disappear by radium rather promptly. Time alone will tell whether radium without operation is advisable.

Radium is a specific palliative in operable cancer of the cervix and uterus. It will clinically cure some of the cases, and subjective improvement is noticed in a certain percentage of others. However, recurrence takes place in many of these clinically cured cases within two or three years. The patient during this interval regains normal health and can lead a useful life. If a recurrence takes place, as a rule the patient suffers little in comparison with those who had no radium treatment. In these hopeless cases, the offensive discharge and hemorrhage usually completely disappear within from two to four weeks. The cessation of discharge, which often is so offensive to the family and even to the patient, is a remarkable feature. The local condition changes in character within from two to four weeks after the treatment; the mass begins to contract and shrink, and continues to decrease in size. This is more marked in some instances than in others. The deodorizing and sterilizing effect of radium is very remarkable in the inoperable or recurrent cases where there is a broken down mass of carcinomatous tissue or a crater-like sloughing extending into the broad ligaments. These cases have a discharge with a very foul odor and run an irregular temperature. One application of radium will alleviate these symptoms and means much to the patient.

Dr. De Wayne Richey has written the following outline on histological changes:

"While the finer appreciation of the histological problems is complex, requiring a thorough understanding of the physical and chemical properties of both the radium and the neoplasm, a more or less superficial examination will demonstrate definite alterations in both the parenchyma and the stroma of the tumor tissue, after radiation. During the past decade or so, numerous contributions along these lines have appeared. The earlier of these noted the rôle of the connective tissue proliferation, even to the point of attributing the destruction of the malignant growth to it and regarding the disintegration of the tumor cells as secondary. Schottlander, in 1915, called attention to the early histological changes in the parenchyma, describing the vacuolar degeneration of the protoplasm and transformation of the chromatin as a specific action of radium. Two years later, Ewing mentioned the early hyperemia of radiumized tissues from the cervical canal, the swollen, homogeneous and hyper-chromatic nuclei, the hydropic vacuoles in the cytoplasm and the fusion of the tumor cells into giant-cell forms in the second week. Following this, a great reduction in the number of neoplastic cells, which appear to have suffered liquefaction, necrosis and compression by the proliferating stroma occurred, until, in the fourth or fifth week after the application of radium, only nuclear fragments or no trace remained.

"Recently Alter, in an exhaustive study of 275 cases of squamous cell cancer of the cervix uteri, confirms many of the findings of the earlier workers and again emphasizes the primary parenchymous involvement with the secondary replacement of the destroyed tumor cells by the ever-increasing

stroma. After the administration of radium, he noted a short latent period followed by inflammatory changes wherein is a marked histo-eosinophilia, along with, during the first week, the appearance of many young, engorged blood channels which penetrate the parenchyma and effect a separation of the epithelial cells. From the second week to the fourth or fifth week definite changes in the parenchyma begin as a swelling of the protoplasm and nuclei, which became pyknotic, progress through vascular degeneration, chromatin disturbances, loss of mitotic figures and dispersion of the protoplasm to the formation of fused chromatin masses, until in the ninth week, these end products of cellular destruction are pinched off into the irregular, small islands by the former cellular stroma which is now taking on hyaline, scar-like characteristics."

From Dr. Richey's statement it is observed that operation is favored in from four to eight weeks after the radiation rather than immediately afterwards. Treatment consists in the local application of either radium or *x*-ray, or both, through a number of ports of entry, directed towards the lymphatic glands which metastasize.

The local application of radium is carried out by most operators on a sounder basis than treatment given from the outside. It is quite generally known what a certain amount of radium will locally produce in a certain class of cases, because in three or four weeks the results of the treatment can at least be partly determined; but we have no method to visualize or palpate the adjacent pelvic or abdominal glands which have often metastasized even in early cases, nor can we determine by any clinical or diagnostic method whether the amount of cross-firing with either radium or the roentgen rays has destroyed the cancer cells in the lymphatics. There has been a controversy going on for the past few years as to whether this can be best accomplished by large quantities of radium or by the roentgen rays. No standard technique has been adopted.

In reviewing the work done by all those who treat carcinoma of the cervix by radiation, I am convinced that the amount of cross-firing done by nearly all, either by radium or roentgen rays, has been insufficient to destroy cancer cells at the desired depths, and many are obtaining very little effect except locally by radium. The treatment of the deep glands has been one which comparatively few of us have been studying during the past ten or fifteen years. Since we know that there are some cases of inoperable carcinoma of the cervix in which the pelvic glands have not been metastasized, some may think they are destroying disease in the lymphatics when there were no cancer cells present. In reality the clinical cure may have been produced by local application of radium, because it will destroy cancer cells at a greater distance than can be reached by the knife.

In a paper, "The Local Application of Radium Supplemented by Roentgen Therapy," read before the American Roentgen Ray Society, Atlantic City, September 24, 1915, I quoted Warnekros and concluded that if a growth was situated four inches below the surface it received about one-seventh of the radiation on the surface. This is probably nearly accurate; but from the work I have since done in the treatment of lymphatic glands in the neck, which later were removed and examined under the microscope, I believe it would require considerably more radiation than we would consider a safe erythema dose, using seven ports of entry, to destroy all cancer cells in the deep lymphatic glands, but most probably by using twenty or more ports of entry this can be accomplished. I have had lymphatic glands in the neck removed and examined after radiation and nothing but the fibrous stroma of the glands was left; but these glands were not situated so deep. The erythema dose must not be confused with the lethal dose. Many are confusing erythema (skin) dose with the amount necessary to destroy cancer cells in the lymphatics, because they have assumed tissue will bear several times the intensity required to destroy basal epithelioma without permanent damage.

During the last six years that I have been treating carcinoma of the uterus, I have used radium locally, supplemented by the *x*-ray or radium externally. From the beginning I gave rather large doses, in milligram hours, of radium locally, and used as many ports of entry externally as was practicable with *x*-rays. The last few years I have employed from three to four thousand milligram hours in the vagina, using one and one-half millimeters of brass, and sufficient gauze and rubber to make fifteen millimeters of filtration. Three tubes were usually employed, one directed towards the cervix and one towards each broad ligament. These tubes were packed as far as possible from the recto-vaginal wall, thereby lessening the danger of a fistula; and unless the uterus was fixed from the disease, the organs were pushed higher up in the pelvis by the amount of packing used, thus giving more efficient treatment to deeper pelvic glands. Each half inch treated means the same as a more radical operation. The importance of this has been overlooked by many and is undoubtedly one of the causes of producing an unnecessary fistula. Involvements of the rectum are nearly always late manifestations of the disease, and the amount of radiation the recto-vaginal wall receives is usually sufficient to destroy outlying cancer cells. The tissues of the cervix are relatively insensitive in comparison with other tissues of the body. It is important to bear this in mind, but we must remember that there is always a limitation to the amount of radium that can be used. Whenever it was possible by any means to insert radium into the cervical canal it was always done, because cancer cells thereby can be reached which could not be reached from the tubes in the vagina.

It has been stated that the therapeutic action extends from a radium tube along a radius of from two and one-half to four cm. —that is, Bumm and others claim that cancer cells are destroyed at this distance without permanently injuring healthy tissue in contact with radium tubes. Then if it is possible to use two or three tubes arranged end to end, this will treat therapeutically at a still greater distance than a tube placed in the cervical opening. However, the therapeutic action of the rays is reduced by absorption as the rays pass through the uterine walls; but if three thousand milligram hours (which is rather a large dose) are given in the cervical canal, cancer tissues at a slightly greater distance will be destroyed. I have given three thousand milligram hours where the disease was limited to the cervical canal, in addition to three thousand hours in the vagina, as described before, making a total local dosage of six thousand milligram hours. If this is given at one treatment it may not need to be repeated. The radium tubes in the cervix are filtered by one-half millimeter of silver, one millimeter of brass and from one to two millimeters of rubber. When six thousand milligram hours are given at one treatment, the patient usually has some discomfort afterwards, and the question of producing a fistula must be considered; but if we are going to treat primary cases without operation, rather heroic measures should be employed, and I am inclined to think that more is accomplished by a single treatment than to have this amount divided into two or more treatments. When such heavy treatment is given the cases should be properly selected and the tubes applied cautiously. It is difficult and impossible to employ the same technic in every case, as each presents variable factors. Lately I have been applying radium over the sacrum to treat the sacral glands, and in a few instances over the inguinal glands.

The following conclusions have been worked out in collaboration with Charles Viol, Ph.D., and thus reported by him:

CONDITIONS FOR THE PRODUCTION OF DEEP THERAPEUTIC EFFECTS WITH HARD *x*-RAYS AND GAMMA RAYS.

"In a paper by Sir Ernest Rutherford on the 'Penetrating Power of the *X*-radiation from a Coolidge Tube' in the September, 1917, *Philosophical Magazine*, the mass absorption coefficient in aluminum for *x*-rays excited at a voltage of 92,000 is given as

0.14 and the corresponding value for the gamma rays from radium—C is given as 0.026. For the x-rays, this represents the most penetrating rays excited at the voltage given, and that is, I am advised, about the highest voltage commonly used. Multiplying the given coefficient by 2.7, the density of aluminum, gives the absorption coefficient in one centimeter of aluminum, these values being respectively 0.378 for the hard x-rays, and 0.0702 for the hard gamma rays. With these two values for the absorption of the x-rays and gamma rays in aluminum as a basis, and setting the density of tissue as a unity, it can be estimated that the absorption coefficient for the two types of rays in soft tissues will be approximately 0.14 for the hard x-rays and 0.026 for the hard gamma rays. To obtain the thickness of the tissue necessary to absorb half of a given type of radiation when the absorption coefficient for that radiation in the given tissue is known, the mathematical relationship is that the half absorption thickness of the substance equals 0.6931 divided by the absorption coefficient. Therefore, with the above absorption coefficient for the hard x-rays and gamma rays it may easily be calculated that the x-rays will be half absorbed in penetrating through 4.9 centimeters of tissue of density I, whereas the hard gamma rays of radium will be half absorbed only if passed through 26.5 centimeters of the same tissue.

"In the application of radium energy to a deep-lying growth, such, for example, as in the attempt to ray malignant extensions in the broad ligaments and lymphatic tissue in advanced cervical carcinoma two factors come into play tending to reduce the intensity of the radiation which reaches the malignant tissue. The first effect is that of the divergence of rays, coming as they do from small sources which for convenience in calculation will be treated as point sources. The other factor is the partial absorption of the rays, which takes place on their penetrating through the tissue lying between the source of radiation and the tissue which it is desired to irradiate.

"In terms of a skin surface or erythema dose, we will calculate the intensity of the hard x-rays available at a point four inches below the skin surface when hard x-rays having the above described physical qualities reach the skin surface from a point eight inches away. On the basis of divergence of the rays, by means of the law of inverse squares, it may readily be shown that the intensity of the radiation four inches below the skin surface is reduced to 0.444 of the skin surface intensity and the four inches of tissue on the basis of the above given absorption coefficient will absorb 75 per cent of the x-rays, so that the intensity per unit area at four inches below the skin surface, in terms of the skin surface intensity as unity, will be $0.444 \times 0.25 = 0.111$.

"As already mentioned, there are two factors coming into consideration in this deep x-ray work, the first being the skin surface dose that can be borne without producing permanent damage, and the second factor is the lethal dose of the hard rays necessary to destroy the malignant tissue. At present we do not know the relationship between the skin surface or erythema dose and the lethal dose for malignant cells, the situation being further complicated by the fact that different types of malignant tissue are of varying responses to the action of the rays and it is not possible in every case to determine exactly the nature of the malignant tissue under treatment. If the skin surface dose were equivalent to the lethal dose for malignant tissue it would be clear from the above figures that the cross-firing of the malignant tissue through nine portals would be sufficient, since one-ninth of a lethal dose could be obtained through each portal. In practice, however, it is known that these two dosages are not equal, since far more radiation is required to destroy malignant cells; and consequently to produce results it becomes necessary to cross-fire through far more portals than nine. The preliminary report by Bumm and Warnekros on the 'Curing of Deep-lying Carcinoma by Roentgen Raying Through the Body Surface,' as reported in No. 29 of the *Muenchener Medizinische Wochenschrift* is the only one we have seen where it is claimed that the x-rays have been

able to influence extensively uterine carcinoma, and since this report is only a preliminary one, it, in itself, is hardly conclusive either as to permanency of results or as to the safety with which such enormous quantities of x-rays may be fired through the abdomen.

"In case of radium it would require quantities of radium at present unavailable were the radium to be placed as far away as eight inches from the skin surface. In practice it has been customary to use a number of radium preparations spread over a suitable area, thereby producing cross-firing, when it was desired to produce effects at any considerable depth.

"With a single tube of radium assumed to be point source one inch above the skin surface it follows that due to the divergence of the rays the intensity at a point four inches below the surface of the skin is reduced to 0.04 of the skin surface intensity, and due to absorption of the gamma rays in the four inches of tissue, the intensity is reduced to approximately 70 per cent of skin surface intensity, so that as a result of these two effects the available intensity of gamma rays four inches below the skin surface is approximately 0.03 of the skin surface intensity. It would therefore require approximately thirty-five times as long application of the radium under the above mentioned conditions to produce a lethal effect in the tissue at four inches below the skin surface as would be required to produce a lethal effect in the same tissue at the skin surface. Obviously such a lethal dose could not be administered by the use of a single tube of radium at a 1-inch distance from the skin surface, since while administering a lethal dose at a 4-inch depth too destructive an action would be produced in the intervening tissues.

"When radium is distributed over a surface to produce a so-called plaque effect, a better utilization of the rays is possible. So, for example, with the same amount of radium distributed uniformly over a square 6 inches on a side, the intensity of rays at 1 inch from the radium plane is only one-fifth that which the same amount of radium would give when the radium is collected in a single point. With the radium distributed as indicated, the ratio of the skin surface dose, 1 inch below the radium plane, to the dose received by the tissue four inches below the skin surface, is practically 8 to 1, which corresponds to the ratio for hard filtered x-rays as given above.

"Schmitz (*Surg., Gynec. & Obst.*, Aug., 1916), has shown that fifty milligrams of radium applied for twelve hours kills carcinoma cells to a distance of one centimeter.

"As showing about all the radiation that the skin will safely bear, Boggs reports the use of 315 milligrams of radium spread over an area of approximately 9 x 10 centimeters at 3 centimeters from the skin surface for fourteen hours. This is a total dose of 4,410 milligram hours. Assuming for convenience that this radiation comes from nine points, centers of rectangles 3 x 3 1/3 centimeters into which the large area is divided, each center therefore is the source of 490 milligram hours of radiation. Having in mind the lethal dose for carcinoma as given by Schmitz, (600 milligram hours effective to 1 centimeter) and taking this as the unit dose, with the above mentioned distribution, the skin surface intensity is 0.371.

"The maximum skin surface dose which can be given without producing serious burns, i.e., the skin erythema dose, is approximately 40 per cent of the lethal dose for carcinoma cells. This result hardly seems to accord with the belief that the carcinoma cells are so much more readily destroyed than the cells of the normal skin; however it must be borne in mind that a truly destructive skin dose has to be avoided, since if the skin reaction produced is too severe, the repair is very slow and the burn painful. It can only be pointed out, however, that the Schmitz results are based upon histological findings on nodules excised ten days after raying, and it is probable that destruction of malignant cells at a greater distance than 1 centimeter would have been observed after 600 milligram hours of radiation, had the action been allowed to go on for a month, at least, before excising the nodule."

ROENTGENOTHERAPY IN MALIGNANT DISEASE WITHIN THE ABDOMEN, WITH REPORTS UPON THIRTEEN CASES*

By GEORGE E. PFAHLER, M.D.

PHILADELPHIA, PA.

I WILL omit any reference to cases of uterine carcinoma, since in these I use both radium and the roentgen rays. Dr. Boggs will discuss that phase of abdominal carcinoma.

Malignant disease within the abdomen, especially if it be primary carcinoma, should be operated upon if there is a reasonable hope of complete removal, and this operation should be followed immediately by active deep roentgenotherapy. The treatment of malignant disease within the abdomen is most discouraging no matter what form of treatment is used. Most of the patients that are referred for roentgenotherapy are either the hopelessly inoperable, the recurrent, or those showing metastasis. Until recently there has been no reasonable hope of curing any of these. The surprising results which I have obtained in a few cases lead me to make this report, but we must always keep in mind, and impress upon the physicians and friends of the patient, that the great majority of these patients will die of the disease no matter what we do. The brilliant result occasionally secured in a patient in whom the disease is far advanced should make us cautious in our prognosis.

Four of these thirteen cases were previously reported before the American Roentgen Ray Society in 1917. These will be briefly reviewed here.

CASE 1. Mrs. J. B., age 47, was referred by Dr. John B. Deaver, October 30, 1907. One and one-half years before Dr. Deaver operated and found the entire omentum involved by tumor tissue. The case was inoperable and he made no attempt at removal of the tumor. He released some of the adhesions which seemed to be producing intestinal obstruction, but advised against any further operation. The patient's general health was good. There was general abdominal tenderness, especially in the hypogastric region and right iliac fossa, plus increased resistence in the latter. She received nine fractional doses during a period of two weeks. Crossfiring was used from two sides of the abdomen only, and the total dosage amounted to one erythema dose over the entire abdomen. She returned February 18, 1908, because of increased pains and symptoms of slowly developing intestinal obstruction. At this time there was a distinct mass to the left of the line of incision and considerable tenderness over the abdomen. Another course of treatment was given consisting of eleven doses, on each side of the abdomen, amounting to one full dose as we speak of it today, since only this amount of crossfiring was used. She returned for another course of treatment June 15, 1908, having had no symptoms of bowel obstruction during this interval of three months. The general tenderness had practically disappeared. The circumference of the abdomen was two inches less than at her previous visit, and the patient looked well. She returned again November 6, 1908, saying that she had been wonderfully well all summer. The abdomen was generally soft. Five fractional doses were given within ten days. She reported for examination October 11, 1912, apparently entirely well, said that she never felt better in her life; and, so far as she or I could tell, she was in perfect general health. On January 20, 1914, she returned, at the advice of Dr. Deaver, for further treatment. At this time she had no definite symptoms, but treatment was given as a precaution against development of the disease. General crossfiring was now used, according to our modern methods. The pa-

*Read before the Midwinter Meeting of the Eastern Section of THE AMERICAN ROENTGEN RAY SOCIETY, Atlantic City, N. J., January 30-31, 1920.

tient seemed to be in good general condition. She was told to go home (for she lived about 200 miles from the city) and to report if any unfavorable symptoms developed. I received Christmas messages during the two succeeding years, but no complaints.

Remarks.—In a sense this is an unsatisfactory report because we had no microscopical study, but the disease corresponds so closely to the other cases reported that I feel it can be included. The patient lived in reasonable comfort during a period of eight or nine years.

Case 2. Mrs. D. MacF., age 57, was referred by Dr. Laura S. Chapin, December 8, 1913. This patient was operated upon by Dr. Barton Cook Hirst, May 18, 1913, nearly seven months previously, at which time nothing was removed, because all of the intestines were matted together by malignant disease. The patient was sent to us for treatment for the relief of pain because, at that time, only large doses of morphine gave her relief. The attending physician had no hope of relieving the disease. A course of twenty doses was given, according to modern technique, over the entire abdomen. At the end of a week she expressed herself as feeling very much better, was able to sleep without opiates, and her bowels moved without purgatives. There was some dermatitis after the first course of treatment and, therefore, the second course of treatment was not begun until April, at which time the improvement was very marked, the entire abdomen being soft; only a small palpable mass was found in the lower left groin. The third course of treatment was given during the latter part of May and the early part of June, 1913. At this time all the disease had disappeared excepting a small mass in the lower left groin. Treatment to this area was given, consisting of four doses, March 31, 1914 and August 31, 1914. She was examined by Dr. Hirst on June 26, 1914, at which time Dr. Hirst could find no evidence of the disease except for a small mass about the size of a hen's egg in the lower left groin. He expressed himself as being surprised and delighted with the results. The patient had also been examined by Dr. Wm. L. Rodman and Dr. Stillwell Burns on March 6, 1914. We all found the abdomen soft, except for this mass in the lower left groin, which was about the size of a hen's egg. Her bowels moved regularly without purgatives. She was free from pain and her general health was good. She neglected to come for treatment or observation after this, and on September 21, 1915, Dr. Samuel H. Brown reported to me that she had died of tumor in the brain. The latter was found at autopsy. The autopsy also showed a sinus of the abdominal wall, ptoses of the transverse colon and hernia, intra-abdominal adhesions, chronic interstitial nephritis, traumatic ventral hernia, adenocarcinoma (medullary) of the sigmoid, and metastatic carcinoma (medullary) of the frontal lobe of the brain on the right side.

Remarks.—As a result of the deep roentgentherapy in this case, the patient lived in reasonable comfort for about a year, and certainly lived a year longer than she would have otherwise. She finally died of metastatic disease in the brain, and not from the disease in the area in which the treatment was given. While in the end the case was a failure, the improvement in her general condition, her general comfort, her relief from pain, and the disappearance of the palpable disease, would lead one to believe that, had she been treated at a time when the disease was reasonably localized, she might have recovered completely.

Case 3. Mrs. J. E. L., age 51, was referred by Dr. E. P. Zeisler of Chicago, Ill., and Dr. C. V. Warner, of Miami, Oklahoma, July 6, 1916. During October, 1915, Dr. Eddie Meyer of Buffalo operated for ascites and obstruction of the bowel. This was found to be caused by a pedunculated ovarian cyst that had become wrapped around the gut. He diagnosed the condition at operation as cyst and peritonitis. In four months she again became filled with ascites, and upon operation at this time, Dr. Meyer found the abdomen filled with

colloid cancer. The pathological report by Dr. Charles A. Bentz is as follows: "The tissue examined consisted of two Fallopian tubes and a piece of omentum. The histological findings are papillary carcinoma of the tubes, with metastasis in the omentum." At the time when treatment was begun, the abdomen was firm. Avidness was complained of, and there were signs of fluid. A course of nineteen doses was given within four days, after which she returned to her home. There was no appreciable improvement at the end of a month, though, according to our original plans, a second course of twenty doses was given. After this she improved very much, though she was nauseated and prostrated following the second course of treatment. She returned for a third course of treatment on October 3, 1916. Her general health had improved, the abdomen was soft, there was no palpable disease, and no clinical evidence of disease whatever in the abdomen. She returned for the fourth course of treatment on December 11, 1916, at which time she appeared to be entirely well. Twelve doses were given in this fourth series, and she was sent home with instructions to report if any symptoms whatever developed, for we believed her to be well. On May 17, 1919 the patient called at my office for examination. The abdomen was normal in every respect. She had a small lymph node in the left supraclavicular region, the origin of which was obscure. We made an examination of the chest, but could recognize nothing abnormal. I advised that this lymph node in the left supraclavicular region be removed and examined microscopically, but up to the present time I have had no report upon the case.

Remarks.—This means that a patient who had had an exploratory operation at which a diffuse colloid carcinoma of the peritoneum was found, the latter having produced ascites in October, 1915, which was inoperable recovered under roentgentherapy and has remained well for approximately four years since treatment.

Case 4. Dr. X. was referred by Dr. Wm. J. Mayo on June 13, 1916, for treatment of general carcinosis of the peritoneum. The patient was operated on May 25, 1916, by Dr. Wm. J. Mayo. Under date of June 6, 1916, Dr. R. D. Carman of the Mayo Clinic wrote: "The *x*-ray examination showed a high cecum and slight filling defect in the sigmoid. These findings were thought to be due to an extrinsic tumor which is palpable in his right iliac fossa. He was explored by Dr. W. J. Mayo, who found a general peritoneal carcinomatosis of unknown origin. The abdomen contained free fluid and great masses of colloid material attached to the peritoneum, omentum, etc. Microscopic section showed carcinoma." Upon the patient's arrival for roentgentherapy there was evidence of free fluid in the abdomen. There was a tumor in the right lower abdomen about the size of a large grapefruit, firmly adherent, with general firmness of the abdominal tissues. He gave a history of having had an attack of appendicitis six years previously, but no operation. Three to four years ago he noticed a swelling in the right iliac fossa. About three months before coming for treatment this tumor, which had grown progressively larger, began to give pain, and obstructive symptoms were noted. He was given a course of deep roentgentherapy, through twenty portals of entry within two days. After this course of treatment he was nauseated; pain was reported in the abdomen, and his temperature rose to 101, pulse 105. He returned for a second course of treatment on July 5. At this time the tumor was only about two-thirds its original size, though he suffered from pain in the epigastrium. The second course of treatment was given within five days. He returned, on August 7, two months after treatment was begun, weighing 157, his weight before the operation was 170 to 177. Improvement in general appearance was noted, but the patient complained of getting tired very easily. The abdomen was softer and the tumor had decreased in size. A third course of twenty doses was given within three days' time. The fourth course was given from September 8

to September 14, 1916, after which he returned to his home in St. Louis, where he was under the treatment of Dr. Ernst. On October 7, 1916 the patient writes: "Feeling very well. Weight 162 pounds. Very little pain in the abdomen, though mass seems as large as ever." He was treated on an average of once a month by Dr. Ernst until July, when Dr. Ernst left for Europe. On August 9, 1917, more than a year after treatment was begun, the patient called to see me. At this time he looked perfectly well, had gained in weight, and had been attending to his practice since February, 1917. Palpation of the abdomen showed nothing abnormal except a slight induration in the right groin along Poupart's ligament, which did not have the feeling of a mass, but only of increased firmness.

Remarks.—This patient, who was considered inoperable and in my judgment was hopeless when he first called upon me on June 13, 1916, has recovered his health, has returned to his practice and has visited me each summer, at which time we found his abdomen soft. During the past year he has had some enlargement of the liver and some suspicion of a recurrence of the disease. In July, 1919, at his visit, we gave him a course of treatment over the abdomen and liver, and on December 20, 1919, he wrote as follows: "I am about the same as last summer. Weight 148. Have had two series of *x*-ray treatment from Dr. Ernst. Eat and sleep well and feel fine." No matter what the future outcome in this case may be, the patient has certainly had his life prolonged by four years, with the hope of many more years; and at the first visit he was as hopeless as any patient I have ever seen.

Case 5. Mr. W. K. S., age 50, was referred to me by Dr. W. S. Bertolet, June 16, 1916, on account of severe stomach trouble and attacks of severe pain in the abdomen. Dr. Bertolet suspected obstruction of the bowel. By *x*-ray examination I found evidence of a carcinoma filling the transverse colon at a point about 2 inches proximal to the splenic flexure, the lumen being reduced to about 1/4 inch. On the night following my examination he developed signs of intestinal obstruction. Dr. Chas. Nassau was called during the night to operate, and resected the carcinoma. He was then sent to me for post-operative *x*-ray treatment. From July 14, 1916, to July 19, 1916, we gave him 16 doses through 16 portals of entry, crossfiring as much as possible in the region of the operation. A similar course of treatment was given in August, September and October, 1916, at which time he was free from symptoms. He returned from time to time for examination. On June 19, 1917, or a year after the original operation, he returned for examination. At this time I found some evidence of constriction at the same location in the bowel. I was unable to decide whether this was malignant, or a contraction of the scar tissue, and therefore gave him another course of treatment, making five courses in all. He has had no treatment since.

Remarks.—The constriction which was noted in June, 1917, has practically disappeared, and at the examination on October 22, 1919, the lumen is restored to practically normal size. He is still in excellent health to-day, three and a half years after operation and post-operative *x*-ray treatment was begun.

Case 6. Mrs. W. L., age 50, was referred to me by Dr. J. B. Roxby, on April 4, 1916, for examination. At this time I found a very advanced and extensive carcinoma of the rectum. The patient was operated upon by Dr. Wayne Babcock on April 11, 1916, at which time he resected the diseased area including most of the rectum, and did a posterior colostomy. She was given 19 doses of *x*-rays between May 11 and May 15, 1916, through 19 different portals of entry, crossfiring chiefly in the location of the former disease. This treatment was repeated in June, August, September and November, 1916, at which time she appeared to be entirely well. She received 11 doses in January, 1917, 8 doses in March, 1917, and 19 doses in September, 1917, at which time she seemed to be well. She re-

ceived 12 doses in February, 1918. At this time she had no abdominal symptoms. In April, 1918, she developed stomach symptoms; a mass was found in the epigastric triangle the size of an orange. This, Dr. Roxby believed, was carcinoma. At this time the patient took up Christian Science treatment, and died April 24, 1918.

Remarks.—This patient died of carcinoma of the stomach, and while she is a failure in that sense, she did not have a recurrence of the disease in the region in which she was operated upon, and in the region in which she received post-operative treatment. When one considers the likelihood of recurrence of carcinoma in the operative field (in this case carcinoma of the rectum), we must look upon this as at least, a partial success.

Case 7. Mr. H. A., age 31, was referred to me by Dr. Wayne Babcock, on February 4, 1915, for post-operative treatment. Three weeks previously he had resected 10 inches of the sigmoid on account of carcinoma, and at the same time removed a number of metastatic lymph nodes. We divided the abdomen into 36 areas crossfiring so far as possible, on the region of the sigmoid, but really covering the entire abdomen. This was repeated at an interval of a month, and again at the interval of the second month, so that in all he had three such series of treatments. Following this he got entirely well and has remained so for almost five years.

Remarks.—We know how rarely these patients with extensive carcinoma of the bowel (especially in a young person) associated with metastasis, are cured without this combined form of treatment, and I believe that we can attribute this brilliant result to the post-operative *x*-ray treatment following a skillful operation. A roentgen study made two years later showed that the lumen of the bowel in the sigmoid was practically normal. He has remained well for approximately five years.

Case 8. Mr. J. J. L., age 38, was referred to me by Dr. Wm. J. Mayo on December 14, 1917. Dr. Mayo had operated on account of a palpable tumor in the left hypochondriac region and found a large carcinoma involving the transverse colon at the junction of the middle and left third. It was irremovable on account of its being attached to the superior mesenteric artery. My examination of the bowel showed a mass occupying approximately 6 inches of the transverse colon, and reducing the lumen of this transverse colon to less than 1/3 normal over an extent of about 3 inches. We began active *x*-ray treatment and gave him 38 doses through 38 different portals of entry in the first series of treatments, between December 12, 1917 and December 20, 1917. A second course of 31 doses was given between January 18 and January 20, 1918. In February, 1918, a re-examination showed that the lumen of the bowel had increased, the tumor tissue had been reduced to about half. The patient's general health had improved, so that upon meeting him no one would have thought he was sick. He had gained 6 pounds in weight. He received a third course of treatment in February, a fourth course in April, a fifth in May, and a sixth in August. At this time he began to fail. The examination of the bowel then showed what I believed to be a perforation and communication between the large and the small bowel. He developed diarrhea and died on September 21, 1918.

Remarks.—This case is, of course, ultimately a failure, but we undoubtedly elicited some response even in this very advanced stage of the disease since, when he first came, he was most cachectic and the treatment was only undertaken as a sort of "last straw." The encouraging thing is that two months later his general health had improved to such an extent that one would have considered him well in looking at him, and that the tumor showed undoubted reduction in size. This proves that, even in these abdominal carcinoma, the *x*-rays can produce a distinct effect. The chief advantage of such observation is to prove that the rays will destroy carcinoma cells within the

abdomen. Therefore, there is a distinct value in post-operative *x*-ray treatment, and perhaps some hope in the inoperable cases.

CASE 9. Mr. J. C. L., age 48, was referred to me by Dr. Ernest Laplace on April 28, 1914. Three years previously he had about one foot of the large bowel resected on account of carcinoma which had caused acute obstruction. The patient was in a state of complete collapse at the time of the operation, and an inguinal colostomy was done. The colostomy was closed about five months before coming to me. Since that time small excrescences had formed about the wound, surrounding which were extensively indurated tissues caused by recurrent carcinoma. He was given *x*-ray treatment over this area. The disease became more fibrous and more definitely isolated. On October 23, 1914, at my request, Dr. Laplace excised the whole indurated area. The patient was then given four doses as a post-operative measure. Treatment was not repeated until March 9, 1915 when he was given four doses over this area. A year later there was evidence of recurrence. We treated this area twice during 1915. Then he seemingly remained well for about two years. He returned November 27, 1917, with a distinct recurrence. The patient received one course of four doses on December 27, 1917, four doses January 21, 1918, another course of four doses on February 18, 1918, and on May 1, 1918 another course of four doses was given. At this time there was an improvement in the carcinomatous condition. The patient remained away until July 24, 1918. At this time his general condition had improved, and he was attending to business regularly. On September 16, 1918 he returned with evidence of new growth and was referred for operation to Dr. Mantz, who excised the entire area. He received one course of post-operative treatment consisting of four doses, but the disease extended, and he died May 11, 1919.

Remarks.—In a sense this is also a failure because the patient died. Yet from the time of the first treatment on April 28, 1914, to his death, May 11, 1919, a period of five years elapsed, and I feel that the rays had undoubtedly retarded the growth.

CASE 10. Mr. B. E. C., age 53, was referred to me by Dr. J. E. Hardy of Waterville, Maine, June 4, 1919. Six weeks previously he had an exploratory operation done on account of severe pain in the right iliac fossa. An advanced and inoperable carcinoma of the cecum was found. Occult blood was found repeatedly in the stools, even before the operation. The tumor was the size of a lemon, and there was involvement of the appendix, and the wall of the bowel, with enlarged glands in the neighborhood. No attempt at removal of the tumor was made, and no section was taken. *X*-ray treatment was begun on June 7, 1919 and 21 doses were given, crossfiring chiefly in the right iliac fossa. This was repeated in July and again in August and September, at which time the induration had greatly decreased and the general health seemed to be good. The patient has returned to Maine to teach school for the winter.

Remarks.—Only a short period has elapsed, of course, since beginning *x*-ray treatment, but nothing was done for this man excepting the *x*-ray treatment, and his improvement in general health and the decrease in the size of the tumor must be accredited to the *x*-rays. Under ordinary conditions he would have grown worse instead of better. He has returned to his occupation as a school teacher.

CASE 11. Mrs. R. M. F., age 31, referred to me by Drs. H. G. Anderson and C. H. Brown of Waterbury, Conn., August 8, 1919. In the latter part of June this patient was taken suddenly ill with cramps in the abdomen. The patient was taken to the Waterbury Hospital and an exploratory laparotomy done by Dr. H. G. Anderson, at which time an inoperable carcinoma involving the small intestines and mesentery was found. About 12 inches of the intestinal

mass was removed. The growth was adherent to the surrounding structures. She had two *x*-ray treatments by Dr. Brown in Waterbury. When she arrived at my office for treatment examination showed a palpable, irregular and indefinite mass, with marked increased resistence on the left side of the abdomen over an area eight by six inches. She was cachectic, weak, and had all the appearances of an advanced carcinoma. *X*-ray treatment was begun on August 12, 1919. At this time she was markedly constipated. One month later her bowels were moving without any laxatives, and she was beginning to do her general housework, which gave her some pain in the left side. Excepting for one day's pain, however, she was entirely free from her former symptoms. A second course of *x*-ray treatment was given. She only had two courses of *x*-ray treatment, each consisting of 15 doses. On November 18th she called for examination. She looked perfectly well and felt perfectly well. Examination of the abdomen showed no induration or conditions to suggest disease. There was no dermatitis present, and to all outward appearances, she has been cured.

Remarks.—This is one of the most remarkable results I have seen because of the prompt improvement. Unfortunately no section was taken at the time of the operation because there seemed to be no doubt as to diagnosis and a removal of a section seemed to be dangerous. She has only had two courses of *x*-ray treatment since I saw her. From a cachectic, emaciated woman, in three months she was restored apparently to normal health, and is attending to all her household work.

Case 12. Mr. G. L. H., age 41, was referred to me by Dr. Edwin Fiske, March 9, 1918. In October, 1916, he had had the right testicle removed on account of carcinoma. This had been developing for 11 months. The pathological report from the Higgins Laboratories, New York, stated: "Carcinoma with secondary inflammation." In this case I secured the specimens removed from the testicle and referred them to my friend, Dr. E. Case, who confirmed the diagnosis of carcinoma. Two months before coming to me the patient discovered a large mass in the upper part of his abdomen. At the beginning of my treatment, in March, 1918, he had a tumor involving the upper part of the abdomen which was approximately the size of his head. The first course of *x*-ray treatment, consisting of 33 doses, was gixen between March 9th and March 30, 1918, crossfiring upon this tumor. He returned in April for a second course of treatment, at which time the tumor was reduced to about the size of a large orange. This time 23 doses were given. He returned in June for a third course of treatment. At this time he looked well, felt well, and we found the tumor approximately the size of a hen's egg. A fourth course of 22 doses was given in July. At this time further reduction in the size of the tumor was evident. A fifth course was given consisting of 10 doses during October 1918. A sixth course was given in January 1919, consisting of 7 doses. A seventh course was given in April 1919, consisting of six doses. An eighth course consisting of four doses was given in July 1919, and a ninth course consisting of four doses was given in October 1919. At this time the tumor had practically disappeared. There was still a faint resistance which would not have been discovered had it not been known that a tumor had existed there. The patient now reports himself as well.

Remarks.—During all this time, from the beginning of treatment, he continued his occupation as a school teacher. He is teaching school to-day, and is to all outward appearances, perfectly well. This is due to *x*-ray crossfiring upon the deep-seated malignant disease within his abdomen, and this disease, to all outward appearance, was a secondary carcinoma within the abdomen due to primary carcinoma of the testicle.

Case 13. Dr. W. D. B., age 43, was referred to me by Dr. Wm. H. Kraemer of Wilmington, Del., Octomer 24, 1917. In January of this same year he first noticed a

ımor about the size of an orange slightly) the right in the lower epigastric region. [e also had an enlarged right testicle. An -ray study showed the chest normal. The ımor was found not to involve the gastro-ıtestinal tract. It was lying back of the owel and according to my report was either a part of the right kidney or a tumor ying over the right kidney. Would suspect ther possible sarcoma or hypernephroma f the right kidney. Examination of the ght testicle by the x-rays showed three alcareous deposits." I advised operation, ut this was not done until April 1, 1918, hen Dr. Draper opened the abdomen and ound a retroperitoneal mass which could ot be removed. The testicle was removed, ut unfortunately was lost before a micro-copical examination could be made. During ne latter part of March, 1919, he was seen ı consultation by Dr. J. Chalmers DaCosta, who made a diagnosis of retroperitoneal ımor, probably sarcoma. A Wassermann est was made which was negative. He was eferred to me for x-ray treatment on April , 1919. This tumor had been growing specially rapidly during the previous ıonth. Dr. DaCosta had advised against urther exploratory operations. When he vas referred to me I made another x-ray xamination and found no evidence of sar-oma within the chest, but the abdomen ontained a number of large abdominal ıasses varying in size from an egg to a fist. The patient was given 19 doses of x-rays in April in his first course of treatment. In May he was given a second course of treat-ıent consisting of 19 doses. In June he was iven a third course of treatment. The tu-ıor suddenly diminished in size. His gen-ral health improved. In July he was given fourth course of treatment. At this time here was only slight hardness present in the egion of the largest tumor. In August he vas given a fifth course of treatment con-isting of 15 doses, and in October he was iven a sixth course of treatment consisting f 8 doses, at which time no palpable tumors ould be found. His general health was ood, and he was working every day on a railroad. He has been seen this week, and is the picture of health. He is still working every day.

Remarks.—This case seemed to be a rather hopeless and certainly inoperable one at the beginning of treatment, and seemingly was suffering from metastatic malignant disease secondary to malignant disease of the testicle. This disease was discovered in the abdomen even before the primary operation on the testicle. Under treatment his general health improved, the tumors gradually disappeared, and he has been restored to complete health. The outcome can, of course, not be definitely stated at this time.

A future report on these cases I believe will be justified.

TECHNIQUE

In the treatment of these patients the aim should be, of course, to cover the entire abdominal cavity, including the liver, and there should always be an x-ray examination of the chest to see whether the disease may have spread there. In none of these cases was there any evidence of metastasis in the chest. The abdomen is divided into from twenty or thirty areas so that every part receives treatment anteriorly and posteriorly. Most of the treatment, however, should be given anteriorly, because of the greater facility in reaching the disease, and the greatest crossfiring should be upon the location of the primary disease.

With our outfits we have been using 40 milliampere minutes, with a focal distance of 8 inches, and with a constant voltage equivalent to a 9 inch parallel spark gap. These rays should be filtered through 6 millimeters of aluminum or glass. I believe that, generally speaking, it is inadvisable to crowd the treatments as close together as had been done in these cases reported, for one is very likely to bring about constitutional symptoms in the form of nausea and prostration. At least a week to two weeks should be used to give such a course of treatment. If this plan is followed, nausea

and prostration should be eliminated. This group of patients require the most serious attention and the greatest amount of skill. It is not work that can be turned over to a nurse or technician or amateur roentgen-therapist.

CONCLUSIONS

1. General carcinomatosis of the peritoneum will sometimes yield remarkably to the influence of deep roentgentherapy.

2. The prognosis, however, must always be most guarded, because this is metastatic carcinoma, and as such is liable to make its appearance elsewhere in the body, eve though marked response is obtained fro abdominal treatment.

3. Colloid carcinoma appears to be mo responsive to roentgentherapy than oth forms of abdominal carcinoma.

4. Post-operative treatment should b given in all cases of carcinoma within th abdomen.

5. Some cases of inoperable carcinoma c the bowels show improvement.

6. Abdominal metastatic carcinoma c sarcoma following malignant disease of th testicle disappears in some cases.

BOOK REVIEWS

Review of the Chicago Number of the *Medical Clinics of North America,* July, 1919. Volume 3, No. 1.

In reviewing this number of the *Medical Clinics of North America,* it is noted that the surgeons and physicians of Chicago take a keen interest and realize the important aid that roentgenology furnishes. This is illustrated by the following papers: Clinic of Dr. Frederick Tice, Cook County Hospital, A Mediastinal Tumor, p. 19. Carcinoma of the Stomach, p. 25. The latter case is of interest in that the autopsy revealed the presence of two metallic foreign bodies in the stomach wall which were not seen during the *x*-ray examination. Clinic of Dr. Milton M. Portis, Cook County Hospital, An Unusual Case of Carcinomatous Metastases in Bones Secondary to Carcinoma of the Stomach, p. 35. This case is of especial interest, because the patient gave absolutely no symptoms referable to the stomach. The roentgenographic findings, however, showed that the bones, namely the lumbar spine ilium and rib showed definite evidence of disease, whic simulated metastatic new growth. This prov that metastatic carcinoma of the bony skelet is not always the result of carcinoma in t prostate, as has been emphasized for son years.

In the clinic of Dr. Julius H. Hess, Coo County Hospital, on the Radiographic Dia nosis of Bone Affections in Infancy and Chil hood, p. 31, there are many points of speci interest. Dr. Hess's paper takes up ve minutely and ably the differential diagnosis b tween osteogenesis imperfecta tarda, rachiti scorbutus, tuberculosis, osteomyelitis, bo acute and chronic, sarcoma, acute infecti periostitis, and syphilis.

Other papers of interest are: Carcinoma c the Esophagus Treated with Radium, p. 6 Syphilitic Periostitis of the Humerus, p. 20 Pulmonary Abscess Following Tonsillectom p. 209; Irregular Placement and Fixation c the Large Bowel, p. 253.

THE AMERICAN JOURNAL OF ROENTGENOLOGY

PUBLISHED BY PAUL B. HOEBER, NEW YORK CITY

Issued Monthly. Subscription, $6.00 per year. Advertising rates submitted on application.
Editorial office, 480 Park Av., New York. Office of publication, 67-69 East 59th St., New York.

TWENTY-FIRST ANNUAL MEETING

The Twenty-first Annual Meeting of The American Roentgen Ray Society will be held at Rochester, Minn., and Minneapolis, Minn., September 15, 16, 17 and 18, 1920; at Rochester on the 15th, at Minneapolis on the 16th, 17th and 18th.

Further details and advance information concerning the meeting will appear in these columns from month to month.

Minneapolis headquarters, Hotel Radisson.

MEETING OF MIDDLE SECTION AMERICAN ROENTGEN RAY SOCIETY

The Middle Section of the AMERICAN ROENTGEN RAY SOCIETY met at the Hotel Congress in Chicago, February 20-21, 1920, at which time the following program was presented: The Correlation of X-Ray and Pathological Findings in the Diagnosis of Bone Lesions, Dr. D. B. Phemister, Chicago; Radiotherapy of Thyroid Malignancy with Report of Case, Dr. James T. Case, Battle Creek, Mich.; A Method for Making "Instantaneous" Roentgenographs of the Heart at Determined Points in the Cardiac Cycle, Professor J. A. E. Eyster, Madison, Wis.; A Preliminary Report on Some Roentgenological Studies of the Feeble-minded, Dr. M. William Clift, Flint., Mich.; Further Roentgen Experience with Oxygen Inflation of the Peritoneal Cavity, Dr. William H. Stewart, New York City; The Treatment of Uterine Fibroids, Dr. Thomas A. Burcham, Des Moines, Iowa; Abdominal Angina, Dr. A. W. Crane, Kalamazoo, Mich.; Cancer Ameliorations and Cancer Immunity, Dr. A. F. Holding, Madison, Wis.; Report of Four Unusual Cases of Malignancy Successfully Treated by Roentgen Therapy, Dr. A. F. Tyler, Omaha, Neb.; A Portable Localizing Fluoroscope, Dr. Edwin C. Ernst, St. Louis, Mo.; Reduction of Fractures under Fluoroscopic Control with Description of a New Unit and Fluoroscopic Table, Dr. Preston M. Hickey, Detroit, Mich.; The Diagnosis of the Pathological Gall-bladder, Dr. A. W. George, Boston, Mass.; Fractures of the Bones of the Face, Dr. Charles F. Bowen, Columbus, Ohio.

The papers were of unusual interest, the attendance was extremely gratifying and every one there felt well repaid for making the trip to the meeting.

The Constitution and by-laws which were adopted by the Eastern Section at Atlantic City were adopted with necessary changes by the Middle Section.

The following officers were elected for the Middle Section:

President
James G. Van Zwaluwenburg, Ann Arbor, Mich.
First Vice-President
Wm. M. Doughty, Cincinnati, Ohio
Second Vice-President
Edwin C. Ernst, St. Louis, Mo.
Secretary-Treasurer
A. F. Tyler, Omaha, Neb.

At the banquet in the evening, sixty-three guests were present. Dr. E. H. Skinner, of Kansas City, presided as toastmaster. Drs. James T. Case, A. F. Tyler and Alexander B. Moore responded to toasts. The banquet was followed by a lantern slide demonstration.

CO_2 INSTEAD OF O_2 FOR INJECTING THE PERITONEAL CAVITY

The February, 1920, number of the *California State Journal of Medicine* contains an article by Walter C. Alvarez of San Francisco, describing his experiences with the injection of the peritoneal cavity by O_2 and other gases, as follows:

After working with the technic of O_2 injections for a few days, it seemed to Dr. Alvarez that its usefulness would have to remain limited largely to hospital patients, unless some means could be found of getting rid of the gas more promptly. Although in most cases the oxygen was sufficiently absorbed in two or three hours, so that the patient could leave the office, few cared to work next day; and one man still had a large amount of gas in his abdomen after five days. Hence Dr. F. B. Taylor and Dr. Alvarez began injecting rabbits at the Hoope Foundation with various gases, and soo found, as was expected, "that CO_2 would b absorbed many times faster than O_2. Afte satisfying ourselves that the procedure wa harmless, we began using CO_2 at the offic and have since made it almost a routine. Th great advantage of this method is that w can assure the patient that in twenty-fiv minutes his gas will be out, his distress wil be over, and he can go back to his work a if nothing had happened." The disadvantag is the difficulty in getting all the plate wanted. Moreover, if a plate should be unsatisfactory for any reason, or if on development something should be found which required further study, it might be too late "We overcome this difficulty somewhat b having three people working rapidly; on developing as fast as the plates are taken It may be, now, that by adding a little O we can slow the emptying a little and ye retain the great advantages which have bee gained with the new technic."

SUMMARY.—A technic is described whic the writer believes marks the biggest step i advance as regards intra-abdominal diagnosis since the bismuth meal was introduced After injecting gases into the peritonea cavity the intestines will float out of th way, and the various organs will mov around so that beautiful *x*-ray plates can b secured of the diaphragm, liver, spleen, gall bladder, kidneys, gastrointestinal tract spine, uterus and ovaries. This technic ha proven particularly helpful in the diagnosi of gall-bladder disease. By using CO instead of O_2 the writer has modified th original procedure so that it may now b used in the office as well as in the hospital Whereas the O_2 leaves the abdomen in from 24 to 100 hours, the CO_2 leaves in half a hour. This seems to be a distinct advanc and certainly merits the consideration of al those who are interested in this type of work

TRANSLATIONS & ABSTRACTS

MEDICAL SCIENCE: Abstracts and Reviews. (Vol. I, No. 2, Nov. 1919.)

Joltrain and Baufle draw attention to the occurrence of localized latent peritoneal tuberculosis in patients with vague abdominal symptoms. *X*-ray examination, which is essential for the diagnosis, shows a dilatation of the lower end of the ileum, in which there is an obstruction to the passage of the bismuth meal. As a rule this dilatation is associated with immobility of the colon, due to the existence of adhesions, which are found not only in the region of the ileum but also throughout the large intestine, especially at the flexures and in the sigmoid.

SURGERY OF THE THYROID AND THYMUS GLANDS

Examination by *x*-ray is of importance as showing the effect of pressure upon the trachea, also as disclosing an enlarged thymus or retrosternal goitre. Deuk and Hofer say that among 1,967 cases operated upon in Vienna for non-malignant goitre, in 11 cases there was softening and collapse of the trachea, necessitating tracheotomy. An *x*-ray plate made anteroposteriorly will show the commoner lateral compression of the trachea, but a lateral plate is necessary in order to demonstrate the rarer anteroposterior compression.

Sgalitzer described his method, by which lateral and anteroposterior plates were made so as to show lengthening and bending of the trachea by the goitre, as well as the level and extent of the compression.

Mayer found that *x*-ray negatives also enabled a diagnosis to be made of interthoracic goitre and enlarged thymus, although a dermoid cyst cannot be distinguished from the above. The retro-sternal goitre may be a continuation of the goitre in the neck, but an intrathoracic goitre may exist without any enlargement of the neck gland. Moreover, accessory thymoids may be met with at any point in the line, from the base of the tongue as far down as the front of the arch of the aorta and pericardium, or even in the posterior mediastinum.

Oehler noted that when the growth in the thyroid was malignant, the outline of the trachea as seen by the *x*-ray was obscured or was not visible at all. The obscuring of the trachea by cancer is probably due to dense infiltration around the trachea, and is distinct from the question whether the cancer is compressing the trachea.

GASTRIC AND DUODENAL ULCERATION

The differentiation of duodenal ulceration was first made by Moynihan in 1901. The following were the chief points in his description: That duodenal ulceration was of more frequent occurrence than gastrict ulceration; that it chiefly occurred on the anterior wall of the duodenum just beyond the pylorus; that men are more frequently affected than women; the occurrence of the so called hunger pains one and a half hours after meals; the pain referred to the right of the midline of the epigastrium and the back of the chest of the same side; the relief of the pain by taking food or an alkali. The periodicity of the attacks corresponding presumably to the healing and recurrence of the ulceration; hyperchloridia as a particular indication of duodenal ulceration; the occurrence of melena including "occult" blood.

GASTRIC SPASM AND X-RAY EXAMINATIONS

Greater experience with the appearances reproduced in *x*-ray photographs and their interpretation has added to the means of making a more exact diagnosis, as well as the recognition of spasm and its causation of pain.

Müller attributed gastric pain, especially during the emptying of the stomach, to irregular spastic contraction of the pyloric third of the stomach, as shown by the *x*-rays. But also, whilst the stomach is empty, spasmodic contractions occur, which may be the cause of the so-called hunger pain. The spasmodic contraction may involve not only the muscular wall of the stomach but also the gastric arterioles. The gastric crises in tabes dorsalis may be explained as due to strong peristaltic and antiperistaltic contraction of the walls of the stomach.

Indeed, the production of pain by hyper-

acidity may be exaggerated. The normal mucous membrane in dogs is not specially irritated by hydrochloric acid, even in excess of the normal, and there are many ulcers of the stomach which do not cause pain.

Fleiner, by *x*-ray examination, explained cardiospasm as starting in the oesophagus and spreading to the cardiac portion of the stomach. No special sphincter was recognized at the cardiac orifice. By means of spasmodic contraction a tube was formed along the lesser curvature of the stomach leading towards the pylorus. The tube so formed was reminiscent of the normal condition of this part of the stomach in ruminants. A continuance of the occurrence of spasm of the lower third of the oesophagus and upper part of the stomach might lead to the formation of cancer with dilatation of the oesophagus above the region of spasm.

Schütze stated that in 60 per cent. of cases suspected of gastric ulcer the *x*-ray photographs presented indentation of the greater curvature of the stomach, which he attributed to hypertonic contraction of the gastric wall with an infolding of the mucous membrane. Whilst in the majority of cases gastric ulceration was indicated, it was also seen in connection with duodenal ulceration, and less often with cholecystitis.

Groedel, however, did not agree with Schütze; indeed he doubted whether such pictures of indentation could be taken as signs of pathological conditions at all.

THE RELATION OF GASTRIC AND DUODENAL ULCERATION TO CANCER

Two recent American communications express doubts as to the frequency with which simple ulcerations degenerate into cancer, and tend to revert to the old view that cancer generally begins as such. According to Ewing, cancer is widespread with extensive induration and uniform infiltration, an erosion with here and there excavations. Simple ulcers are circumscribed with smooth overhanging edges; there is, however, often a glandular hypertrophy with fibrosis of the submucosa which produces a resemblance to cancerous infiltration.

Willensky and Thelimer examined microscopical specimens of gastric ulceration. Thirty-nine specimens proved to be instances of simple chronic ulcer in accordance with the naked eye appearances. Seven specimens in which the appearance at the operation resembled carcinoma, proved also to be simple ulcers. One was a specimen of simple ulceration, but there was a nodule of carcinoma at one margin. In cases of carcinoma so early that the lymphatic glands are not involved, an excision carried 2 cm. beyond the ulcerated margin appeared to remove all the malignant disease.

There does not, however, appear to be any trustworthy means of distinguishing cancer when exposed at the operation, at least at a stage early enough to promise success after excision, except by the immediate examination under the microscope of a fresh section.

Troell reported on the fate of the cases diagnosed in the Stockholm Hospital as irremovable cancer of the stomach during the years 1907–14.

One hundred and thirty-seven cases were diagnosed as cases of irremovable cancer and were treated by gastroenterostomy. Of these, 70 were reported upon later; 60 died within one to thirty-five months of cancer, 9 of them surviving more than a year. The average duration was seven and a half months. Seven died of cancer at an unknown date; 3 were alive and free from cancer eight years, seven and a half years, and six years later respectively.

One hundred and thirty-four cases were diagnosed as cases of irremovable cancer of the stomach as the result of exploration, without anything further being done. Fifty-two of these were reported upon later; 49 died within one to thirty-five months, 3 living longer than a year; 1 died of cancer at an unknown date; 2 were alive six and three quarters years after without a sign of cancer.

Thirty cases were diagnosed as inoperable cancer of the stomach without any exploration: 26 died within one to twenty-six months; 1 died seventeen months later of tuberculosis; 3 were alive without any sign of cancer eight and a half, eight and a quarter, and four and a half years later respectively.

Statistics from the same hospital of 90 cases of cancer of the stomach treated by excision concluded that the average duration of life after the excision was from fifteen to twenty months, as compared with seven and a half months after gastroenterostomy.

The primary mortality among the cases of cancer was:

In the 25 per cent. submitted to excision, 19 per cent.

In the 38 per cent. submitted to gastrojejunostomy, 17 per cent.

In the 37 per cent. submitted to exploration, 16 per cent.

i.e. an average primary mortality of about 18 per cent.

Thus in selected cases the mortality following the excision of the cancer did not greatly exceed those following the gastrojejunostomy.

Gastrojejunostomy when malignant disease is present is attended by more than double the mortality which follows the operation in cases of simple ulceration.

Ransohoff, J. Louis. Late Results in the Radium Treatment of Cancer of the Uterus. (*J. Am. M. Assn.*, Vol. 74, No. 3, p. 163, Jan. 17, 1920.)

What place shall radium have in the treatment of carcinoma of the cervix? This is a question of vital importance, as it concerns the treatment of a disease of universal distribution, a disease which in spite of the efforts of the world's greatest surgeons continues to take its large annual toll of suffering and death.

Carcinoma of the cervix has long been one of the most fruitful fields for radium treatment. Thousands of cases are annually declared inoperable and must needs be aided by some other means than surgery. Because of its unusual accessibility, radium can be brought into close contact with the neoplastic cervix where it can exert its direct influence.

Radium has long been granted its position as the agent of choice in the treatment of inoperable cervical carcinomas. The question which now concerns us is whether it shall supplant the radical operation in the treatment of so-called operable cancers of the cervix. I say "so-called" advisedly, as the question of operability depends entirely on the judgment of the individual operator, and in numerous instances cannot be definitely decided until after the abdomen has been opened.

With the publication of an account of the Wertheim operation in 1898, and its adoption by the leading gynecologic clinics of the world, it was thought that a step forward had been taken in the war against uterine cancer; but now, after two decades, the Wertheim operation is still on trial. One of the most distressing phases of carcinoma of the uterus is the low percentage of operability among those patients applying for relief. In a decade, Clark[1] operated on sixty patients and estimated that during the same period more than 300 were refused operation, an operability of only 15 per cent.

In Jacobson's[2] collection of 5,027 cases, only 1,720, or a little over 31 per cent, were considered operable. In reviewing the statistics of the Wertheim operation it would seem that the higher the percentage of operability in a given series of cases, the higher the percentage of operative deaths. Probably more discouraging than the small percentage of operability is the high immediate mortality. The operative mortality of Jacobson's collected cases was 18.25 per cent. These figures, bad as they are, nevertheless leave too optimistic an impression, as they represent the work of the most skilled gynecologists of the world. In the hands of the great body of operating surgeons, the mortality is undoubtedly far larger.

Peterson,[3] in his own cases, had a total primary mortality of 25.4 per cent. In speaking of the operation he says:

"Unquestionably added experience has strengthened my belief that the extended operation for cancer of the cervix is an exceedingly dangerous one, always attended by high primary mortality. No one will be more glad to discard the radical abdominal method than will I, if I can be shown that more patients can be ultimately cured by less dangerous methods."

Turning again to Jacobson's statistics, of 1,090 patients operated on that were followed, there were 386 cures, or 35.41 per cent of the patients that were traced, or only 19.32 per cent of the entire number of patients operated on; but what is most striking is that only 11.72 per cent of all those patients applying for treatment were cured.

Clark has struck the keynote of modern opinion of the Wertheim operation. He says:

"If an operation or other therapeutic process is to have a permanent place in our armamentarium it must be sufficiently easy to make it available not for a few skilled specialists, but for the great body of surgeons working in every quarter of this and other countries."

In these days of low mortality percentages attending nearly all major operations, no operation can possibly gain headway which com-

bines with it a shockingly high mortality and a large majority of distressing and desperate sequelae. The effect on the lay mind must be taken into consideration, for while one may have over 50 per cent of ultimate cures among those patients that survive the operation, the effect on the average intelligent citizen is abhorrent, if for this number of survivors there have been twenty-five deaths, and for the other twenty-five a wretched existence attended by repulsive postoperative sequelae, followed by a painful and lingering death. It is possible that when we make a final summary of our combined experiences we may have to accept the conclusion that a less radical operation, even though it saves fewer patients, may be preferable when attended by a low surgical mortality and few or no operative sequelae.

A CONTRAST OF METHODS

Disregarding for a time the end-results of radium treatment of cancer, it is interesting to compare the two methods of treatment from other standpoints. Contrasted with the high mortality of the extensive operation for uterine cancers, there is practically no mortality from the radium treatment. In place of a dangerous operation with its attendant suffering, long stay in the hospital, and distressing postoperative sequelae, there is the simple radium treatment with a few days' stay in the hospital, no danger and little pain.

Again, while less than one third of those patients who present themselves for treatment are fit subjects for the radical operation, radium treatment is available for all classes of cases, no matter how far advanced. The immediate result of treatment, and the palliation of symptoms, the relief from hemorrhage, pain and foul discharge have been too frequently described to warrant further comment.

The conclusions published by Dr. J. Louis Ransohoff [4] in 1916 remain unchanged. That is, in all cases the immediate results have been without exception good. The concern now is, Can radium permanently cure cancer of the cervix? If so, does the percentage of cure equal that of operation? If that is true, the conclusion is obvious.

The pendulum is swinging toward radium as the method of choice in the treatment of operable cervical carcinomas. With the report of later results, its position is becoming more definitely established. As early as 1914, there were some operators convinced that radium should entirely supplant operation. Dobbert [5] in that year, from an observation of twenty-four cases, eighteen inoperable and six operable, concluded that it was justifiable to use radium alone in the treatment of operable cases. Cheron [6] reported an inoperable case in which radium was used. Two and one-half years after treatment, death occurred from intercurrent disease. Necropsy revealed no trace of cancer.

In 1915, Döderlein [7] definitely advocated the use of radium in operable cases. Pozzi,[8] in 1915, had given up the Wertheim operation in borderline cases and treated them with radium alone. In cases which are decidedly in their inception, a simple vaginal hysterectomy is done, followed by prophylactic radium treatment. Flautau,[9] in 1915, definitely relinquished operation in favor of radium. The title of his article was, "May We Trust Radium Alone in the Treatment of Uterine Cancers?" In the same year, DeGrais [10] reported both operable and inoperable cases free from recurrence four years after treatment.

A very important contribution is one of Recasens, a Spanish surgeon. In the beginning he used radium only in those cases too far advanced for operation; but later he used radium to the exclusion of operation. He believes that in very early cases, a cure by radium is almost certain.

RESULTS IN THE AUTHOR'S SERIES OF CASES

As Dr. Joseph Ransohoff and Dr. J. Louis Ransohoff began the use of radium in the treatment of malignant disease in February, 1914, this report represents the results of nearly six years' experience.

On Dr. J. Louis Ransohoff's return after two years in the army, he was interested in the fate of those patients whom he had seen in the three years prior to his entrance into the service. With the exception of the last case, which was two months later, this series includes those cases observed between February, 1914, and April, 1917, a period varying from two and one-half to nearly six years. As far as possible, all patients were traced; those that could not be located were regarded as having succumbed to the disease.

There are in all thirty-two cases. This includes all patients observed, varying from those whose cases were operable to those in a

terminal stage of sepsis. There are also included cases in which for one reason or another the treatment was not complete. It is interesting to note that eight of these patients had what was considered an incomplete course of treatment, that is, three or less radium applications. The average number of applications for all cases, healed and fatal alike, was six. There were six recurrent and twenty-six primary cases treated. There were two cases of cancer of the fundus, and thirty of cancer of the cervix, so that this report deals principally with cervical carcinoma.

Of this entire series there were six patients, or 19 per cent, well and free from all evidence of diseases at intervals varying from nearly three to five and one-half years after treatment. In the two cases of carcinoma of the body of the uterus, the results have been disappointing. Neither of these cases, however, was operable. Nevertheless, he is of the opinion that these patients when possible should be operated on rather than treated with radium, as the operative mortality is low and the end-results good. One of these cases is worth reciting in detail:

Miss C. M., aged thirty-four referred by Dr. Palmer, had been having uterine hemorrhages for eight months. Three weeks before my examination, a curettage revealed an adenocarcinoma of the body of the uterus, which was confirmed by microscopic examination. The first radium treatment was given July 3, 1914. In July, 1917, the patient was well. During the fall of 1918, she developed a pernicious vaginal hemorrhage, which was controlled by roentgen-ray treatments. Examination revealed what was thought at that time to be a large fibroid. A month before, these hemorrhages had again recurred. A piece was removed for section and proved to be an adenocarcinoma. One reason for the persistence of this tumor was probably the age of the patient, as it is well known that carcinoma is far more malignant in young persons than in those who are older.

Deducting the eight cases in which an incomplete series of treatments were given, we have 25 per cent relief from symptoms during this period. There has been no definite operable case in which the treatment has not been successful.

Case 1. Mrs. I. F., aged fifty-three, six months before had noticed sudden pains in the lower abdomen and for four months had suffered from bleeding from the uterus. The family history was negative. Examination, April 28, 1914, revealed an ulcerating epithelioma involving the entire anterior lip of the cervix. The uterus, however, was freely movable. A small piece removed for examination revealed epithelioma. The first radium treatment, September 11, 1914. Hemorrhage ceased after the first three treatments, and there had been no evidence of recurrence. The patient was in perfect health. In July, 1919, examination revealed a normal movable uterus, with no evidence of any ulceration, a freedom from recurrence after five and a half years.

Case 2. Mrs. K. H., aged seventy-one, for seven months had had severe vaginal hemorrhages. Examination disclosed carcinomatous degeneration of the entire cervix. There was a microscopic diagnosis of carcinoma. The uterus, however, was movable. The first radium treatment was given May 1, 1915, and the last treatment, May 29, 1915. There were in all four treatments. The patient was reported well, April, 1919, a freedom of recurrence after four and one-half years.[11]

Case 3. Mrs. S., aged forty-five, had been bleeding off and on for eight months. She was very much exsanguinated and was severely emaciated. Examination revealed a cancerous mass filling the vagina. A microscopic diagnosis of carcinoma was made. Under an anesthetic the mass was curetted away, the vagina was cauterized, and 100 mg. of radium were inserted for twenty-four hours. March 20, 1915, the first treatment was given, and the last treatment was given, May 7, 1915. April 25, 1919, examination revealed the patient perfectly well and able to do her work Her weight was 124½ pounds. September 10, 1919, a rectovaginal fistula developed. Examination under anesthesia disclosed a very small fistula in the posterior vaginal wall, communicating with the rectum. This fistula was situated just above a very dense fibrous stricture. Under an anesthetic, the stricture was stretched and a very careful examination revealed no evidence of cancer. Here the stricture was probably due to the concentration of a large number of treatments in a short time, necessitated by the desperate nature of the case. An examination made a week ago demonstrated the fistula nearly healed and absolutely no evidence of

any tissue remotely resembling carcinoma, a freedom from recurrence for four and a half years.

Case 4. Mrs. S. S., aged sixty-five, had been bleeding for eight months. Examination disclosed the cervix entirely replaced by the neoplastic tissue. There was a foul discharge and hemorrhage. A microscopic diagnosis of carcinoma was made. The first treatment was given in February, 1916, and the last treatment in April, 1916. Examination, November, 1919, revealed the patient in excellent health. The vaginal vault and the remains of the cervix were covered by smooth, pliable mucosa; there was no evidence of a recurrence, a freedom from recurrence of nearly four years.

Case 5. Mrs. J. W., aged fifty, with symptoms present for eight months, had had severe hemorrhage. The site of the cervix was occupied by a crater and cancerous vegetation. It was probably a borderline case. Under gas oxygen anesthesia, a curettage was performed. A microscopic diagnosis of carcinoma was made. The first treatment was given, December, 1916, and the last treatment, July, 1917. Examination, December, 1919, revealed a woman in excellent health, with no evidence of recurrence. There was a small scar in the vault of the vagina covered with normal mucosa, a freedom from recurrence for three years.

Case 6. Mrs. B., aged fifty-four, was operated on for cancer of the uterus two years before. She had had hemorrhage for the past two months. The vagina was narrow, and there was a recurrence in the vault. The first treatment was given in June, 1917, and the last treatment in December, 1917. The patient reported by letter, November, 1919, that she was well, a freedom from recurrence of two and a half years.

COMMENT

We have here 19 per cent of those patients treated free from recurrence for from two and one-half to five and one-half years; one patient for five and one-half years; two patients for over four years; one patient for three years, and one for two and one-half years. The latter case may perhaps be a little too recent to be definitely called cured. This percentage of cure may seem small, but it compares favorably with that following operation. Deducting the eight cases in which the treatment was incomplete raises the percentage to 25.

The remaining twenty-six patients are either known to have died of the disease, or have at present a recurrence, or could not be traced.

Just a word here as to technic, that is, the question as to whether the radium treatment should be preceded by a curettage or the cautery. From their observation it would seem that the results were the same one way or the other; therefore they have definitely given up both curettage and cauterization as preliminary to radium treatment, and now depend entirely on the radium.

If the cases were chosen for radium treatment with the same degree of care that they are chosen for operation, he feels confident that the percentage of cures would be very large. This is not, however, the function of the radium workers, who should give an opportunity for relief to every person who seeks treatment.

There is scarcely any case so far advanced that some improvement may not be obtained from radium treatment. In this work it should be the province of all observers not to work for statistics, but to give every patient a chance, if not for a cure, at least for an amelioration of symptoms.

Contrast the results of these thirty-two cases in which there was a 19 per cent cure, with the Jacobson statistics, in which there was only an 11 per cent cure. Also remember that there was no fatality from this entire series of treatment. Contrast this with the 18.25 per cent mortality from the radical operation. Contrast again the economic saving of weeks in the hospital, the postoperative suffering, and the unbearable sequelae. He does not hesitate to state that in his opinion radium treatment should entirely supplant operation, not only in the treatment of inoperable cases, but also in the treatment of operable cases of cancer of the cervix.

W. W. Belden.

REFERENCES

Clark, J. G.: The Radical Abdominal Operation for Cancer of the Uterus, *Surg. Gynec. & Obst.* 16: 255, 1913.

2. Jacobson, quoted by Janeway: *Surg., Gynec. & Obst.*, September, 1913.

3. Peterson, Reuben: *Surg., Gynec. & Obst.*, 23:280 (Sept.) 1916; *Tr. Am. Gyn. Soc.*, 1916.

4. RANSOHOFF, JOSEPH, and RANSOHOFF, J. L. *Ann. Surg.*, September, 1916.
5. DOBBERT, T. Ergebnisse der Behandlung des Gebaermutter-Krebses mit Radium, *St. Petersburg Med. Ztschr.* 39: 97, 1914.
6. CHERON, H.: *Fortschr. a. d. Geb. d. Roentgenstrahl.* 21: 229, 1913.
7. DÖDERLEIN, A.: Unsere weiteren Erfahrungen mit der Mesothorium Behandlung des Carcinoms, *München. med. Wchnschr.* 61: 225, 1914.
8. POZZI, S.: Rev. de. gynec. et de chir. abd. 23: 2, 9, 9. FLAUTAU: *Zentralb. f. Gynak.*, 39:611, 1915. 264, 1914-1915.
10. DEGRAIS, P.: *Ann. de gynec. et d'obst.* 11, 1919; *Surg., Gynec. & Obst.* 22: 298 (March) 1916.
11. Since this article was written, this patient has died of some inter-current disease, at the age of 76.

DR. PETIT DE LA VILLEON. The Extraction of Intrathoracic Projectiles. (*Am. J. Surg.*, Vol. XXXIII, No. 12, December, 1919.)

THE SURGICAL PRINCIPLE

A blunt instrument, introduced slowly into he lung parenchyma, living and healthy, causes no damage, provided that it follows a ingle tract, and does not penetrate the region of the hilus. This is the fundamental law on which the method is based, a physiological law never before formulated, and possibly disputed, but which I believe, may be accepted as true. On account of the elastic and resilient consistency of the living and healthy pulmonary parenchyma, the blood vessels and bronchial structures, which are not attached to anything, nor obstructed by anything are turned aside by the blunt end of the instrument, and the forceps passes by them.

THE REGION OF THE HILUS

"A scapulo-vertebra trapezium limited internally by the spine, externally by the vertebra border of the scapula in its lower half, above by the fifth rib, below by the eighth rib." Projectiles that throw their shadow in this trapezium, and situated at a depth of from 6 to 14 centimeters beneath the posterior projection of the shadow, occupy the hilus region forbidden to the forceps. Up to the present time surgeons have not dared to attack these projectiles in the hilus, but impelled by the dangers of foreign bodies in this location and the possibility of formidable hemorrhage which might result from them, operators have begun to take courage. Le Fort and Pierre Duval have had had good results with brilliant methods, and for projectiles in this region the author advises "Posterior radio-operative thoracopneumotomy." The operation may be performed under strong red-orange light, under x-ray with the fluoroscopic screen, or by white daylight. Aided by resection of the posterior ribs, and by a total pneumothorax, he enters the hilus from behind forwards, completes the extraction, and packs with a deep tampon. The tampon is removed after two or three days according to the case, always with extreme gentleness. He thus operated upon 17 cases, with 17 cures, two of the cases developing empyema. In pleural and diaphragmatic situation of projectiles surgery can accomplish the removal, without danger, if the surgeou is eclectic and varies his methods. Extraction with forceps under the fluoroscope through the buttonhole incision is admirably adapted to all projectiles in the pleura, excepting only in the mediastinal pleura. Here, if the surgeon decides to intervene, he should do so only with all resources available for major thoracotomy, according to the method of Delarine, Fonta, Pierre Duval, or Le Fort. At the level of the diaphragm, he suggests that projectiles be divided into three groups, according to the region which they occupy. First group; projectiles in the right diaphragm. Second group; projectiles in the left diaphragm. Third group; projectiles in the medium or mediastinal diaphragm. In conclusion, extraction of intrathoracic foreign bodies has been improved considerably by perfection and simplification of the technique, particularly by the association of the x-ray in radio-operative methods.

VACCAREZZA, DR. RAUL F. Las Intoxicaciones Por El Subnitrato de Bismuto.

This article fails to produce any new facts in regard to poisoning with subnitrate of bismuth. After relating a case of fatal poisoning with bismuth subnitrate at the Instituto Modelo De Clinica Medica, and mentioning several others happening in the same place, and also referring to similar cases in literature, the author describes very extensively the intoxication of external as well as of internal origin; Beck's paste has caused a large number of poison cases and several fatal ones.

Poisoning sometimes follows the administra-

tion of large doses as administered in radiographic examinations. There also are reported quite a number of cases where large doses of bismuth subnitrate were given for a long time in the treatment of gastric ulcers. The most important symptom is a generalized cyanosis, and almost all these cases proved to be due to obstruction at the pylorus or in the intestines, thus allowing the bismuth subnitrate to accumulate and to be absorbed in the gastrointestinal tract.

The acute poisoning is due to the absorption of nitrates formed in the intestinal tract from the subnitrate under the influence of certain intestinal bacteria. They are very rapidly absorbed in the blood where the hemoglobin is changed into methoglobin. Another reason is that if the salt is administered in an alkaline medium it very quickly chances into a soluble albumen which is quickly absorbed through the mucosa of the mouth and lips.

On account of this poisoning action it is out of the question to employ the subnitrate of bismuth in radiographic examinations of the gastrointestinal tract, as very large doses have to be given. In administering the subnitrate of bismuth as a therapeutic measure in gastrointestinal diseases this danger prevents its continued use, and if used it must be employed only in very small doses. In external use also it must be employed with much care, never exceeding the dose of 30 cubic cm. of Beck's paste of 10 per cent.

Peer M. Lund.

THE AMERICAN JOURNAL OF ROENTGENOLOGY

Editor, H. M. Imboden, M.D., New York

VOL. VII (NEW SERIES) MAY, 1920 No. 5

REPORT OF A CASE OF THYROID METABOLISM

By C. W. SCHWARTZ, Ph.B., M.D.

Department of Roentgenology, Peter Bent Brigham Hospital

BOSTON, MASS.

THE following case is reported not so much because it offers anything new in care or therapeutic technique, but more to give courage to others in attempting to relieve similar extreme cases of hyperthyroidism.

Through the kindness of Dr. Lawrence Reynolds I was permitted to undertake the treatment of this case, after it had been referred to us from the medical department.

The patient, a young man twenty-seven years old, was admitted to the medical service on Sept. 12, 1919, complaining of extreme nervousness and restlessness, which seemed to be getting worse.

The family history was negative except for the fact that his mother evidently suffered from hyperthyroidism.

The past history is interesting because it elicits the fact that for several years he has been subject to attacks of fidgeting and twitching. Two years ago following an attack of pleurisy he had more or less of a nervous breakdown, the chief symptoms of which were fidgetings and insomnia, although he usually sleeps well. For the past three years nocturia has occurred about thrice each night. His best weight was 143 pounds seven years ago; on entrance to hospital it was 135.

The present illness has had rather a gradual onset, extending over the past year. Although always restless he has gradually become more so until now he is unable to keep his arms or head still, and his eyeballs twitch. Small matters began to worry him, and he noticed that he easily became exhausted. Five weeks ago he ceased work on the advice of his physician. During the past three weeks the nervousness has markedly increased, and his eyes occasionally became blurred. Two weeks ago he noticed an enlargement of his neck. No cardiac symptoms are evident. He now has enuresis.

The physical examination shows typical hyperthyroid symptoms such as enlargement of the gland, which is more marked on the right; a loud bruit, tachycardia, exophthalmos, lid lag, tremor of hands, sweating, etc. incidently his Wassermann is positive, and he has Hutchinsonian teeth.

On Sept. 29th his basal metabolism was found to be +65, and although receiving 5000 calories daily with complete rest in bed, he continually lost weight.

On Oct. 8th his metabolism was +95. Some doubt was expressed as to this really being a basal reading, due to his continual twitchings, so bromides were suggested but had no effect.

It was at this stage of the disease that the patient was referred to the *x*-ray department.

The pulse remained for the past few days at about 120, and the urine contained sugar.

The treatment was begun very cautiously, for with such a high metabolism, and the patient's nervous condition, his immediate reactions were somewhat problematical. Hence it was decided to give two or three small thymus doses first. These consisted of about 1 Hampson tint using a 9 in. gap with 5 mm. of aluminum as a filter.

Nothing remarkable happened after these trial doses, so after about ten days his metabolism was again done. It was +116, while the choreiform movements were increasing and his weight decreasing.

Under these rather extreme circumstances it was deemed best to use more intensive measures. So on Nov. 17th, 20th, and 24th, he had three doses to the thyroid over different areas, and on Dec. 1st one over the thymus. Each of these doses consisted of 3 Ha tints (¾ erythema) through 3 mm. Al. with a 9 in. gap.

After this series of treatments his pulse dropped from 132 to 92, but rose to 120 by Dec. 7th. Sugar was continually in the urine.

On Dec. 20th the metabolism was again done and found to be +79; he looked and felt much better. The pulse was 120, but the fundamental rate taken during sleep was only 100 to 110, whereas this was 120. The urine was sugar-free and he was gaining weight.

On Dec. 22nd, 27th and 30th he had a similar series to the thyroid, and during the following two weeks he showed steady improvement in weight, and the choreiform movements were practically gone.

The metabolism was now found to be +60.

On Jan. 13th, 16th and 21st the thyroid was again exposed. Following this his pulse remained low, his weight steadily increased, and the enuresis left him.

This time the metabolism was down to +49.

Although his metabolism was still much too high, still it was decided to allow things to remain as they were for a while, and see if a further drop would not occur without more treatment; for of course we know that the final effects of treatment not infrequently manifest themselves long after therapy has ceased. Hence after bringing down the metabolism 67 points, we thought it best to rest on our oars awhile, and watch the drift.

It might be interesting to report later on this case, after perhaps a year has elapsed, for undoubtedly thyroid cases should be followed over long periods of time really to establish the fact as to whether or not our cures are permanent.

REPORT OF FOUR CASES OF MALIGNANT DISEASE SUCCESSFULLY TREATED BY ROENTGEN THERAPY*

By A. F. TYLER, B.Sc., M.D.

OMAHA, NEB.

THE following case reports are of interest because of the extent of the disease and the technique employed in successfully treating them:

CASE 6626. Mrs. F. H., forty-four years old. Weight 90 pounds. Four years ago she noticed a lump in the right breast. In July, 1915, she consulted a doctor who found trouble in both breasts. Later, she visited the Mayo Clinic, where it was found she had cancer of the uterus, liver and both breasts. She was referred for roentgen therapy, coming December 13, 1915.

Technique.—105 K. V., 6 millimeters of aluminum and sole leather, 8 inch anode skin distance. A total of 1050 milliampere minutes divided into fourteen series.

Results.—She has had eighty-seven treatments, comprising fourteen series, covering the entire torso from the chin to the pubes, front, back and both sides. When she came she was bedfast and unable to eat or sleep because of the pain. Her pain disappeared, the uterine hemorrhage ceased, she gained weight, was able to sleep, and eat anything she liked. She has been doing her own housework for more than three years. Both breasts are soft and the liver is barely palpable, while the uterus is freely movable and normal size.

CASE 8445.—Mrs. A. F. S., forty-seven years, married. Up to three months previous to our examination, May, 1918, she had been well and her menstrual periods had been regular. At that time, she began to bleed profusely and constantly, which continued to the time of our observation. One month previous to our observation she was curetted and cauterized, as the whole pelvis was filled with a mass.

Diagnosis.—Massive carcinoma filling the pelvis.

Treatment.—105 K. V., 6 millimeters of aluminum and sole leather, 8 inch anode skin distance, 5 milliamperes, 15 minutes over each area, covering the abdomen from the navel to the pubes and corresponding area on the back. One such series in May, June, July, August, October and November. No treatment since.

Results.—She ceased flooding after the second series and has had no show since. Recent examination shows the uterus normal size and appearance and freely movable. No glands are palpable.

CASE 8990. Mr. D. C. C., fifty-six years, married, farmer. January 1, 1918, his throat began to get sore with difficulty in swallowing. In May a local physician sent him to Denver for diagnosis, when Dr. E. C. Hill examined a section and found it to be small round cell sarcoma. Later, Dr. Bevan recommended ligation of the carotid artery and radium therapy.

Examination.—July 19, 1918. Patient swallows liquids with difficulty, can only speak in a whisper. The entire pharynx is filled with a growth, smooth in character and apparently arising from the right tonsil. The right submaxillary and cervical glands are enlarged to the size of the patient's fist.

Treatment.—105 K. V., 6 millimeters of aluminum and sole leather, 8 inch anode skin distance, 200 milliampere minutes over each side of neck and down over the mediastinum. He had a second series of treatments one month later, using the same setting, giving 175 milliampere minutes. Two months later he had a third series with the same setting, using 150 milliampere minutes.

Results.—The third morning, after hav-

* Read at the Midwinter Meeting of the Middle Section of THE AMERICAN ROENTGEN RAY SOCIETY, Chicago, February 22, 1920.

ing had only two days' treatment, he walked into the office very happy because he had been able to eat a breakfast of griddle cakes, swallowing them without difficulty. A recent examination showed no evidence of the growth or of metastasis. He is in good health nineteen months after treatment.

Case 10357. L. R. Age ten.

When eight years old he began to lose his sight. In December, 1918, he was examined by a competent ophthalmologist, who found a double optic atrophy and destruction of the sella turcica. Early in January, 1919, he was examined at the Mayo Clinic, where the above findings were confirmed, and in addition the roof of the pharynx was bulging and microscopical examination of adenoid tissue proved it to be fibro-sarcoma.

Roentgen examination at beginning of treatment.—Complete destruction of the sella turcica with the floor pushed down into the sphenoid space. Measurements, 25 x 25 mm.

Treatment.—105 K. V., 6 millimeters of aluminum and sole leather, 5 milliamperes of current, 8 inch anode skin distance, 15 minutes through each area, using three portals of entry over each temple and one between the eyes. He had one such series in February, one in March, one in April, one in May, June, July and September, 1919. He has had no treatment since.

Results.—When he first came he was barely able to distinguish light from darkness. Now he can read type 8 point size, the bulging has disappeared from the pharynx, and the sella turcica is filling in normally.

These cases are typical of some of the worst forms of inoperable malignancy, one showing carcinoma of both breasts and the uterus; one carcinoma of the uterus with fixation in the pelvis and involvement of the pelvic glands; the third, massive small round cell sarcoma of the tonsil with extensive involvement of the glands of the neck; the fourth, sarcoma of the middle fossa of the brain involving both optic nerves. The first patient has been well three years; the second nineteen months; the third, nineteen months; and the fourth, thirteen months. In none of them has there been any evidence of metastasis to date.

These cases emphasize the necessity of employing proper technique in roentgen therapy. I feel that we can learn a lesson from the radium therapeutists in giving massive doses of highly filtered rays. Every physician who has studied the question of technique in roentgen therapy of malignant growths has admired the results obtained by Pfahler of Philadelphia. A number of years ago I became an ardent admirer of him, and learned from him the technique which he was employing. At that time, I was failing in a percentage of cases in which I thought success ought to be obtained. I immediately went home and taking those same patients, applied the technique followed by Pfahler and succeeded in getting them entirely well. This practical demonstration of the value of the highly filtered rays accompanied by high voltage so impressed me that I have never deviated from it since that time in treating malignant new growths.

It is interesting to note the letters I have received from different men throughout the country; and with the exception of three, none of them are using real deep therapy technique as I understand it. Many men claim they get the same result by using a 7 inch spark gap and a 3 millimeter filter. My only answer to that kind of an argument is that experience has not proven this to be true in my case. I have been using as a routine all of the voltage which the Coolidge tube would carry, never using less than 95 kilo-volts, and when possible, going up closer to 115 than to 95. I have been using a parallel spark gap on my treatment transformer, and during the entire treatment keep the spark just spitting across 9¾ inches of air space. I am living in a rather dry climate, so I am getting more voltage with a 9¾ inch spark gap than one would get in a damp climate with the same spark gap, due to the fact that dry air has greater resistance to the passage of electricity than has moist air. Up to the present time I have been using a

treatment machine equipped with a rheostat control. When one is using a treatment machine equipped with an auto-transformer control, one can keep the voltage reading constantly at a certain point without using the parallel spark gap. Along with this high voltage I have been using 6 millimeters of aluminum and sole leather as filters. I have been using as a routine 5 milliamperes of current at an 8 inch anode skin distance. Measured by Hampson's radiometer—using this technique—it requires five minutes to give an erythema dose with the pastille resting on the skin underneath all of the filters. When I am treating malignant new growths I do not stop at the pastille erythema dose, but as a routine use three times the pastille dose, or 75 milliampere-minutes of current with the technique described above. In extensive diseases, where there is considerable vascularity and the condition points toward the fact that we should get as quick an action as possible, I even give as high as 225 milliampere-minutes, or 9 times the pastille dose over the same area. Of course I do not advise this extreme dosage without caution because this produces a burn. The reaction from it is tremendous, but when the growth is located in the soft tissues near the surface so that ulceration will do no harm, I employ it. I also employ this maximum dosage in the treatment of sarcoma. The burn produced by this treatment heals very quickly and looks and acts like the burn produced by radium. Practically speaking, I think this technique and dosage has the same clinical effect as radium treatment. I have a statement from Hirsch of New York who is using only a 4 millimeter filter and a 9 inch parallel spark gap at sea level. He claims that by measuring the amount of rays passing through 4 millimeters of aluminum by means of a Christen meter, he finds there is little advantage gained by the additional 2 millimeters of aluminum. Arthur F. Holding did considerable experimental work during the years 1912-17, relative to the value of different thicknesses of filters, using the photographic effect of the ray upon sensitive plates. His report shows little difference in the photographic effects of the ray when passed through 4 millimeters of aluminum and when passed through 6 millimeters of aluminum. Even though this test on the photographic plate shows little difference when 4 or 6 millimeters of aluminum filter is used in my hands, as well as in the hands of Pfahler, Boggs and Ballard, the clinical effect on the patient is considerably different. There is more caustic action on the skin with the same dosage using 4 millimeters filter than when using 5 millimeters filter. The growth does not seem to melt down as fast under the thinner filter as under the thicker filter and high voltage. The skin recovers more quickly when the heavy filter and high voltage are used than when the thin filter is used. Of course the better effects may be due to the high voltage rather than to the amount of filter. I am convinced that both elements, together with the massive dosage, are responsible for my results.

In conclusion, it would seem that a standard technique could be adopted for deep therapy. The author favors 105-115 K. V., together with 6 millimeters of aluminum and sole leather filter working at an 8 inch anode skin distance. This technique combined with massive dosage in experienced hands will result in the maximum good from deep *x*-ray therapy in malignant growths.

PATHOLOGICAL FINDINGS IN ONE THOUSAND ROENTGEN RAY EXAMINATIONS OF THE DIGESTIVE TRACT*

By W. WARNER WATKINS, M.D.

Pathological Laboratory

PHOENIX, ARIZ.

"THE study of living pathology," says Deaver,[1] "is the important contribution of modern surgery to the medical sciences." This can be said just as truly of roentgenology. Leonard [2] in his memorable "Report on Radiography of the Stomach and Intestines" thus expressed it: "The *living* anatomy, physiology and pathology (of the digestive tract) has yet to be written, and this can only be done as the results are determined by the study of the living patient by the roentgen method."

The advantages of studying living pathology by the roentgen method, over the exploratory operation advocated by Roberts,[3] will appeal at least to the patient. In his article, speaking of the limitations of the roentgen examination, Roberts says: "A negative roentgen ray diagnosis of a gastrointestinal lesion should never be regarded as final in the exclusion of gastrointestinal disease." No roentgenologist would ever so regard it; only the too credulous internist or surgeon takes this view, just as he frequently, and very erroneously, regards a negative Wassermann as excluding syphilis. Not only will the roentgenologist not regard his own negative findings as conclusive, but he will not regard the negative exploration of the abdomen by a surgeon as final, unless the hollow viscera are all opened and inspected and the solid viscera all removed and examined by a tissue pathologist. We ask only two things: first, that our work be regarded not as an "*x*-ray diagnosis," but as a consultation roentgen examination in which we desire a full knowledge of the clinical history and symptoms of the patient, to be correlated with our own observations; second, that our *positive* findings be given the consideration which they deserve, as opinions of consultation specialists; if these opinions are supported by the positive demonstration of pathology, so much the better; if they are only opinions, let them carry the weight to which they are entitled in the mind of the clinician by reason of the "pathologic knowledge, experience and scientific honesty" desired by Roberts in *x*-ray interpretation.

This report of one thousand *x*-ray examinations has a threefold object: To tabulate the findings in patients coming to the general practitioner with chronic symptoms referred to the digestive tract; to illustrate the importance of thorough gastrointestinal *x*-ray examinations, no matter how definite the symptoms may appear; to demonstrate the frequency of certain lesions and of combined lesions of the digestive tract.

These one thousand patients were examined between May, 1916, and November, 1919, and were referred by thirty-five physicians and surgeons. They all came with definite symptoms in the digestive tract or with evidence that gastrointestinal diseases were present. Four hundred came without a history or any information as to the character of the symptoms; 270 with symptoms pointing to stomach or duodenal lesions; 155 with symptoms suggesting gall-bladder disease; 140 with symptoms suggesting appendix disease; and 35 with symptoms suggesting lesions of the colon.

The lesions found in the 400 patients with indefinite symptoms are shown in Table I. The findings were negative in 92 patients; uncomplicated appendix disease was found in 90; duodenal ulcer in 28; stomach ulcer in 18; peritoneal adhesions in 38; chronic gall-bladder disease in 27; tuberculous colitis in 18; diverticuli of the colon in five; cancer of stomach in five; cancer of colon in five,

* Read at the Winter Meeting of the Pacific Coast Roentgen Ray Society, San Francisco, Cal., December 5-6, 1919.

vith isolated cases of several other condi-ions. There were 53 cases in this group howing multiple lesions.

The lesions found in the 270 patients coming with symptoms of stomach or luodenal disease are shown in Table II. Jncomplicated gastric or duodenal lesions vere found in 137, multiple lesions in 21, vith negative findings in 57.

The lesions found in the 155 patients with ymptoms of gall-bladder disease are shown n Table III. In 89 of these a diagnosis of gall-bladder disease, with or without com-plications, was made; lesions outside the gall-bladder were found in 27, and the ex-minations were negative in 44.

The lesions found in the 140 patients coming with symptoms pointing to appendix lisease are shown in Table IV. In only 26 of these were the findings negative, patho-ogical conditions in the appendix region be-ng found in 97.

The lesions shown in the 35 patients with ymptoms limited to the colon, are shown in Table V.

In Table VI, the pathological conditions found in the entire series are listed in the order of their frequency, and some of these esults will bear discussion.

Negative results in the x-ray examina-ions of 240 out of 1000 patients with defin-te symptoms in the digestive tract are not surprising. They are due to one of three easons: (a) failure on the part of the clin-cian to have a complete examination; (b) eflex symptoms in the digestive tract caused by lesions elsewhere; (c) failure to demon-strate the lesions present. The first of these causes is the most important one in this series, but lack of space prevents a discus-sion of this fault on the part of the clinician.

Chronic Appendicitis: The most interest-ng observation in this series is the fre-quency of chronic appendix disease. The lit-erature of the past ten years on chronic appendicitis is strikingly similar to that of twenty-five or thirty years ago on acute ap-pendicitis, in the wide variety of opinions both as to the existence of such a condition, and as to the proper treatment for it when its reality is admitted. The *Journal of the American Medical Association* in 1907 [5] re-viewed an article by Klemm of the previous year and said, among other things: "The fact that there are chronic cases in which there are no definite attacks and but few symptoms referable to the appendix has been recognized for some years. * * * There is little doubt that cases of this sort are fre-quently overlooked and diagnosed as intes-tinal indigestion or dyspepsia." Since that time numerous articles have appeared with the utmost variance in opinion. The absolute negative view is represented by Cabot [6] who tabulates 15,000 cases of chronic dyspepsia, 12,600 of them caused by non-gastric condi-tions, among which chronic appendicitis is not included, even as a possible cause. Bevan,[7] Connell,[8] Williams and Slater,[9] and Roberts [3] take the stand that chronic appen-dicitis is greatly over-estimated and should not be taken seriously unless there is a defin-ite history of an acute attack. If these writ-ers are weak in their pathology, they have, at least, excellent legal backing, since the Circuit Court of Appeals of Maryland [10] has handed down a decision to the effect that chronic appendicitis is not a disease; that acute appendicitis is an emergency demand-ing treatment, but chronic appendicitis is only a misfortune which may or may not call for medical attention. The opposite extreme, that pathological changes in the appendix, whether obliteration, fibrosis, adhesions, or inflammation, are emergencies demanding surgery, is upheld by Sonnenburg,[11] Riche-lot,[12] Schwartz,[13] Bastedo,[14] Bassler,[15] Pfeiffer,[16] Aaron,[17] Jacobson,[18] Bristow,[19] and Vivian.[20] What may be termed the con-servative view and the one, therefore, most likely to be correct, is taken by Deaver,[1] C. H. Mayo,[21] Murphy,[22] Horsley,[23] Brew-er,[24] Moynihan,[25] Graham, Stanton, Lichty [28] and Cheney.[29] These latter writers recognize chronic appendicitis as a cause of gastrointestinal symptoms, and have vary-ing explanations for the observation that appendectomy frequently fails to relieve

the symptoms complained of by the patient.

The argument of Williams and Slater [9] that, because a diseased appendix is frequently found incidental to other operations, it is, therefore, an innocent condition, is no more justifiable than would be the similar claim that gall-stones should be disregarded because they frequently exist without symptoms. The fact that a patient may carry a pathological condition indefinitely without distress is no proof of its innocence as a potential or actual danger. The contest about chronic appendicitis, as with other lesions, centers on the border-line cases where the internist and surgeon differ as to treatment, and endeavor to make the roentgenologist assume the responsibility of the decision. Where we have been foolish enough to do this, we have come into well-deserved disrepute. This decision is not our function. We should demonstrate the pathology, if we can; if we cannot demonstrate it, we may give an opinion as to the conditions present, without ocular proof on the radiograph. But to say whether the appendix should be removed and whether the patient is to look for relief afterwards, is not within our province; this is a matter of the skill and thoroughness of the surgery plus the wisdom and persistency of subsequent medical treatment. Stanton,[27] in his critical paper on Postoperative End Results in Chronic Appendicitis, says that unless it is perfectly evident that the appendix is the sole offender, the gall-bladder, stomach and right kidney should be explored. Frequently a direct operative procedure can be substituted for this exploration by the x-ray demonstration of other lesions complicating appendix disease.. Leede [30] calls attention to the observation that many symptoms considered to be due to chronic appendicitis are caused by associated colitis, typhlitis, or movable cecum. Wilms [31] has called attention to the importance of a long and movable cecum. Brown [32] believes that the misinterpretation of conditions around the cecum and the lack of cooperation between the surgeon and physician in these chronic cases, explains many operative failures. Pfeiffer [16] thinks the failure of many operations to relieve pain is due to inattention to the meso-appendix. Horsley [23] says: "Operations for chronic appendicitis, while practically free from mortality, do not always relieve morbidity. The essential cause of unrelieved pain is the fact that the condition which produced the pain was not relieved. Either the diagnosis was not accurate, and such diseases as stone in the kidney, spinal arthritis, ulcer of the duodenum or stomach, Lane kink, were not excluded, or else the local conditions about the appendix were not correctly interpreted."

The statements of Bevan, Roberts, Connell and others, that a chronic appendicitis, without history of an acute attack, should not be taken seriously, is not in harmony even with the pathology of the acute condition. When an acute gangrenous appendicitis can occur without pain, why cannot, much more frequently, lesser degrees of appendix infection occur without pain? Moschcowitz,[33] Pfeiffer, McCarty,[34] and other pathologists have shown that a mucosal appendicitis has no occasion to be painful, since the sensory nerves of the appendix are in the meso-appendix. Jacobson [18] thinks an acute appendicitis is simply the violent sequel of a chronic and usually painless process which develops the proper local conditions for an acute inflammation. This view is interesting, since this series includes several cases showing chronic appendicitis on x-ray examination who were operated for acute appendicitis weeks or months later. We believe with Goltman [35] that the term "symptomless appendicitis" is incorrect, because no pathology is without symptoms; but we do firmly believe that an acute appendicitis may be painless and that chronic appendicitis usually is painless.

We should like to review the excellent work done by roentgenologists on chronic appendicitis, for their observations have crystallized the differences in opinion mentioned, and it will be their continued work which eventually will clarify the situation and establish the correct pathological under-

standing of chronic appendicitis. Because of lack of space, we can only say that the work reported here is in accord with the viewpoint of roentgenologists in general.

In a gastrointestinal examination, the roentgenologist may find demonstrable pathology in the appendix, either as the only abnormality, or in association with other lesions. This pathology may be visualized in an appendix which is retrocecal and tender, kinked, constricted, irregularly filled, adherent to adjacent structures, containing concretions, or atonic and unable to empty. He may infer appendix disease from other pathology found in the ileocecal region, such as adhesions, Lane kink, obstruction at the valve, cecal stasis, etc. He can utilize the inflation test described by Bastedo with a colon enema, the pinching test described by Bassler, or observe the pylorospasm reflex mentioned by Aaron. He is then entitled to report that there is a pathological appendix which, in his opinion, is capable of producing local or reflex symptoms or both.

After appendix disease has been established, the clinician or surgeon still has several things to decide: (a) whether the diseased appendix is actually the cause of the symptoms complained of by the patient; (b) if so, whether there are associated causes outside of the gastrointestinal tract; (c) if other gastrointestinal lesions are shown by *x*-ray, what relation they bear to the symptoms, and whether they are surgically remediable along with the appendix; (d) to what extent conditions like atony of the colon, constipation, ptosis of the cecum, neuroses of the stomach, some of which will have been demonstrated by the *x*-ray examination, will be corrected by the proposed surgery and subsequent medical treatment; (e) whether the patient will be amenable to postoperative medical treatment.

Our observations that chronic appendicitis produces chiefly reflex symptoms, no leucocytosis, but gives characteristic roentgenological findings, confirms the previously reported conclusions of Cheney [29] and Vivian [20] that the condition may be chronic from the start, and an acute onset of any sort is not essential to a diagnosis; that the patients either complain of stomach trouble or vague abdominal distress; that the radiographic examination is indispensable (Cheney).

In the series of one thousand patients, no fewer than 323 showed pathological appendices, this being the only demonstrable pathology in 212. There were 25 additional cases with ileocecal adhesions where the appendix was not shown; 29 cases of combined ulcer and appendicitis, and 46 cases of combined appendix and gall-bladder disease.

Chronic Cholecystitis: Next to appendicitis, chronic gall-bladder disease was the most common lesion found. We wish to state, without apology, that we follow the teaching, technic and conclusions of George[36] in gall-bladder work. His conclusions are: (1) The normal gall-bladder will not be shown on the radiograph; (2) a distinct and unmistakable gall-bladder shadow means a thickened wall or abnormally dense fluid; (3) such a shadow, with or without stones, means chronic cholecystitis; (4) chronic cholecystitis is a surgical condition. We do not, therefore, regard it as an error if we diagnose a chronic cholecystitis and fail to show stones which are afterwards found at operation. We have never had the experience of Roberts [3] in securing a shadow of a normal gall-bladder.

This series gave 183 patients with chronic gall-bladder disease, which was the sole pathology in 124 and was found in combination with other lesions in 59 cases.

Ulcer: Duodenal ulcer was found in 124 patients, being the only lesion in 91, and existing in combination with other lesions in 33. Stomach ulcer was demonstrated in 93 patients, alone in 62, and in combination with other lesions in 31.

We have learned to believe that the clinical symptoms are not sufficiently characteristic to permit an unqualified differentiation between stomach and duodenal ulcer, and usually warn the clinician not to place his ulcer too confidently, as it is likely to

be dislocated by the *x*-ray examination.

Adhesions involving the colon were found in 50 cases, 38 of these giving indefinite symptoms.

Cancer of the stomach was found in 36 patients.

Tuberculous Colitis was found in 24 patients, 18 of these giving indefinite symptoms. This finding was usually unexpected by the clinician, confirming Lawrason Brown's [37] statement that the symptoms depended on for diagnosis by the clinician are late developments in tuberculous colitis, and that it can be diagnosed by *x*-ray before it gives clinical symptoms.

Stomach Syphilis probably was not found as often as it occurred, being diagnosed only five times, two of these being congenital in infants. Two additional cases, diagnosed as cancer, proved to be syphilis.

Pyloric Stenosis was examined for seven times, being found twice and relieved by operation; three infants showed spasm without stenosis, and two proved to have congenital syphilis.

Diverticuli of the colon was diagnosed nine times, and duodenal diverticuli four times.

COMBINED LESIONS

The most interesting and instructive cases in this series were those showing combined lesions. This group, no doubt, would have been much larger had a complete examination been made in all cases, since many of the cases operated for a single lesion showed other lesions.

Ninety-five patients showed two distinct lesions and nine had triple lesions.

There were forty-six patients with combined gall-bladder and appendix disease; sixteen patients with duodenal ulcer and chronic appendicitis; thirteen patients with stomach ulcer and chronic appendicitis; eight patients with both stomach and duodenal ulcer; three cases of duodenal ulcer and gall-bladder disease; two cases of stomach ulcer and gall-bladder disease; one case each of appendicitis and ureteral stone; appendicitis and duodenal diverticulum; appendicitis and colon diverticuli; appendicitis and tuberculous colitis; appendicitis and spondylitis; duodenal ulcer and tuberculous colitis; duodenal ulcer and stomach cancer; gall-bladder disease and tuberculous colitis.

The triple lesions were as follows:

Six cases of gall-bladder and appendix disease with ulcer.

One case of gall-bladder disease with both stomach and duodenal ulcer.

One case of stomach and duodenal ulcer and chronic appendicitis.

One case of gall-bladder disease with stomach ulcer and tuberculous colon.

TABLE I

LESIONS FOUND IN PATIENTS WITH INDEFINITE SYMPTOMS.

Number Examined, 400

Negative	(23%)	92
Chronic Appendix Disease only	(22.5%)	90
Adhesions, (colonic)		38
Combined Gall-bladder and Appendix Disease		30
Duodenal Ulcer		28
Gall-bladder Disease		27
Stomach Ulcer		18
Tuberculous Colitis		18
Appendix Disease with Stomach or Duodenal Ulcer		15
Ileocecal Adhesions		14
Diverticuli of the Colon		5
Cancer of the Stomach		5
Cancer of the Colon		4
Stomach Syphilis		2
Appendix and Gall-bladder Disease with Stomach Ulcer		2
Incompetent Ileocecal Valve		1
Gall-bladder Disease with Ulcer		1
Chronic Appendix with Ureteral Stone		1
Chronic Appendicitis with Duodenal Diverticulum		1
Negative Gastrointestinal with Spondylitis		1
Cancer of Lungs and Liver		1
Negative Gastro-intestinal with Kidney Stone		1
Duodenal Ulcer, Gall-bladder Disease with valve obstruction		1
Negative Gastrointestinal with Adhesive Pericarditis		1
Duodenal Ulcer with Tuberculous Colon		1
Infantile Pylorospasm		1
Gall-bladder Disease with Tuberculous Colon		1

TABLE II

LESIONS FOUND IN PATIENTS COMING WITH DEFINITE SYMPTOMS OF STOMACH OR DUODENAL DISEASE

Number Examined, 270

Findings Negative	(21.5%)	57
Duodenal Ulcer		57
Stomach Ulcer		42
Cancer of Stomach		30
Chronic Appendicitis		26
Gall-bladder Disease		17
Stomach and Duodenal Ulcer		8
Appendix Disease and Ulcer		7
Pylorospasm		4
Stomach Syphilis		3
Gall-bladder Disease and Appendicitis		3
Duodenal Diverticuli		3
Tuberculosis of the Colon		2
Ulcer and Gall-bladder Disease		2
Ulcer, Gall-bladder and Appendix Disease		2
Appendicitis and Diverticuli		1
Ulcer and Tuberculous Colon		1
Cancer of Esophagus		1
Negative Gastrointestinal with Aneurism of Descending Aorta		1
Pyloric Stenosis		1
Diverticuli of Colon		1
Duodenal Ulcer and Stomach Cancer		1

TABLE III

LESIONS FOUND IN PATIENTS WITH SYMPTOMS OF GALL-BLADDER DISEASE.

Number Examined, 115

Negative Findings	(28%)	44
Gall-bladder Disease	(55%)	78
Gall-bladder Disease with Appendicitis		8
Chronic Appendicitis		7
Duodenal Ulcer		6
Ulcer with Appendicitis		3
Stomach Ulcer		2
Gall-bladder Disease with Ulcer		2
Stone in Liver		1
Diverticuli of Colon		1
Negative Gastrointestinal with Aneurism of Descending Aorta		1
Appendicitis plus Duodenal Diverticulum		1
Gall-bladder Disease, Appendix Disease with Ulcer		1

TABLE IV

LESIONS FOUND IN PATIENTS WITH SYMPTOMS OF APPENDIX DISEASE.

Number Examined, 140

Negative Findings	(18%)	26
Chronic Appendicitis		88
Ileocecal Adhesions		9
Appendix Disease plus Ulcer		4
Gall-bladder plus Appendix Disease		5
Gall-bladder Disease		2
Appendicitis with Tuberculous Colitis		2
Tuberculous Colitis		2
Stomach Ulcer, Gall-bladder Disease with Tuberculous Colitis		1
Chronic Appendix with Spondylitis		1

TABLE V

LESIONS FOUND IN PATIENTS WITH SYMPTOMS OF COLON DISEASE.

Number Examined, 35

Negative Findings	12
Colonic Adhesions	12
Incompetent Valve	4
Ileocecal Adhesions	2
Diverticuli of Colon	1
Chronic Appendix	1
Colitis	1
Enlarged Spleen	1
Appendix and Gall Bladder Disease	1

TABLE VI

LESIONS SHOWN BY x-RAY IN ONE THOUSAND PATIENTS WITH GASTROINTESTINAL SYMPTOMS

Negative Findings

Absolutely Negative	231
Negative, with Enlarged Spleen	1
Negative, with Aneurism	2
Negative with Cancer of Esophagus	1
Negative, with Spondylitis	1
Negative, with Kidney Stone	1
Negative with Adhesive Pericarditis	1
Negative, with Cancer of Lungs	2
Total Patients with Negative Findings for Gastrointestinal Pathology, (24%)	240

Appendix Pathology

Chronic Appendicitis alone	212
Ileocecal Adhesions	25

Table VI *(continued)*

Appendicitis with Gall-bladder Disease	46
Appendicitis plus Ulcer	29
Appendicitis, Gall-bladder Disease and Ulcer	6
Appendicitis and Ureteral Stone	1
Appendicitis and Duodenal Diverticulum	1
Appendicitis and Colon Diverticuli	1
Appendicitis and Tuberculosis of Colon	1
Appendicitis and Spondylitis	1
Total Patients showing Appendix pathology (32.3%)	323

Gall-Bladder Disease

Chronic Cholecystitis	124
(31 cases showed gall stones)	
Gall-bladder and Appendix Disease	46
Gall-bladder Disease and Ulcer	5
Gall-bladder Disease, Ulcer and Appendicitis	6
Gall-bladder Disease and Tuberculous Colon	1
Gall-bladder Disease, Ulcer and Tuberculous Colon	1
Total Patients Showing Gall-bladder Disease, (18.3%)	183

Duodenal Ulcer

Duodenal Ulcer alone	91
Duodenal Ulcer and Appendicitis	16
Duodenal and Stomach Ulcer	8
Duodenal Ulcer and Gall-bladder Disease	3
Duodenal Ulcer, Gall-bladder and Appendix Disease	3
Duodenal and Stomach Ulcer and Gall-bladder Disease	1
Duodenal Ulcer and Cancer of Stomach	1
Duodenal Ulcer and Tuberculosis Cerum	1
Total Patients showing Duodenal Ulcer, (12.4%)	124

Stomach Ulcer

Stomach Ulcer alone	62
Stomach Ulcer and Appendicitis	13
Stomach and Duodenal Ulcer	8

Table VI *(continued)*

Stomach Ulcer, Gall-bladder and Appendix Disease	3
Stomach Ulcer and Gall-bladder Disease	2
Stomach Ulcer and Adhesions	2
Stomach and Duodenal Ulcer with Gall-bladder Disease	1
Stomach Ulcer and Tuberculous Colon	1
Stomach Ulcer, Gall-bladder Disease and Tuberculosis of Colon	1
Total Cases with Stomach Ulcer (9.3%)	93
Colon Adhesions	50
Cancer of the Stomach	35
Do. with Duodenal Ulcer	1
Total	36
Tuberculous Colitis	20
With Ulcer and Gall-bladder Disease	1
With Gall-bladder Disease	1
With Ulcer	2
Total	24
Diverticuli of Colon	9
Syphilis of the Stomach	5
Cancer of the Colon	5
Duodenal Diverticuli	4
Valve Incompetency	5
Pyloris Stenosis in Infants	2
Pylorospasm without Stenosis	3
Stone in the Liver	1

Through the courtesy of Drs. Willard Smith, W. O. Sweek, E. Payne Palmer and Geo. E. Goodrich, the operative findings on 146 patients of the reported series have been secured, and are given in Table VII, in parallel columns with the x-ray findings. For the sake of convenience those cases in which there was disagreement in the x-ray and operative findings are given first (Nos. 1-35):

TABLE VII

x-RAY AND OPERATIVE FINDINGS IN 146 CASES SHOWN IN PARALLEL COLUMNS.

Case	Serial X-ray	X-ray findings	Operative findings.
1.	3810	Ileocecal and colon adhesions; gall-bladder not examined.	Ascending colon densely bound by adhesions; gall-stones.
2.	6301	Duodenal ulcer; appendix not examined.	Old duodenal ulcer; chronic appendicitis.
3.	4047	Duodenum adherent to gall-bladder; appendix not examined.	Adherent gall-bladder; chronic adherent appendicitis.
4.	8481	Stomach only examined. Negative.	Tuberculous enteritis and appendix.
5.	4100	Stomach and colon negative. Gall-bladder not examined.	Chronic gall-bladder and appendix disease.
6.	8042	Stomach only examined. Negative.	Chronic appendicitis.
7.	4494	Stomach only examined. Negative.	Chronic appendicitis and salpingitis.
8.	3171	Stomach only examined. Negative.	Tuberculous peritonitis.
9.	4618	Chronic appendix; cecum only examined.	Duodenal diverticulum. Chronic appendix.
10.	9304	Stomach only examined. Negative.	Perforated appendix.
11.	6346	Stomach and gall-bladder negative. Cecum not examined.	Acute appendicitis some months later.
12.	6020	Stomach only examined. Negative.	Acute appendicitis later.
13.	8470	Negative.	Adherent subacute appendicitis.
14.	6074	Negative.	Acute appendicitis later.
15.	4543	Negative.	Acute appendicitis later.
16.	3812	Chronic appendicitis. Chronic gall-bladder disease.	Acute, gangrenous appendix several weeks later; gall-bladder not examined at operation.
17.	2987	Pyloric ulcer; chronic appendicitis.	Chronic appendicitis; no ulcer by palpation.
18.	6705	Duodenal ulcer; ptosis of cecum.	Chronic appendicitis; ulcer not felt by palpation.
19.	4196	Duodenal ulcer.	Chronic appendicitis; ulcer not felt.
20.	8809	Duodenal ulcer; chronic appendicitis.	Chronic appendicitis; no ulcer felt.
21.	8660	Pyloric ulcer.	Subacute appendicitis; no ulcer felt.
22.	7099	Pyloric ulcer.	Acute appendix on chronic base; no ulcer felt.
23.	6082	Enlarged and thickened gall-bladder; pyloric ulcer; chronic appendicitis.	Very large gall-bladder with 586 small stones and one large stone in common duct; no ulcer felt; chronic pancreatitis. Appendix not examined.
24.	5109	Early cancer of stomach.	Disappeared under antiluetic treatment.
25.	7308	Possibly malignant colon.	No malignancy; adhesions at splenic flexure.
26.	9008	Probable cancer at splenic flexure.	Annular constriction at splenic flexure,—not malignant.

Table VII *(continued)*

Case	*Serial X-ray*	*X-ray findings*	*Operative findings.*
27.	9578	Duodenal ulcer.	Carcinoma of pancreas, involving gall-bladder and duodenum.
28.	10112	Adhesions 2nd portion of duodenum. Gall-bladder disease (?)	Pyelitis and kidney abscess; adhesions to retroperitoneal duodenum; chronic appendicitis.
29.	3010	Neoplasm of stomach.	Nothing abnormal found in stomach.
30.	7531	Diverticuli of colon.	Pelvic adhesions; no diverticuli.
31.	9916	Diverticuli of colon.	Mesenteric adhesions; no diverticuli.
32.	4976	Normal stomach; chronic appendicitis.	Gastric ulcer; chronic appendicitis.
33.	8348	Cancer of pylorus.	Cholecystitis with stones and adhesions to pylorus.
34.	4110	Chronic gall-bladder disease.	Chronic appendix disease.
35.	3102	Gall-bladder disease with one stone.	No stone found; thickened gall-bladder.
36.	3839	Obstruction at splenic flexure.	Obstruction at flexure due to floating left kidney.
37.	6027	Chronic appendicitis.	Chronic appendicitis.
38.	7193	Chronic appendicitis with concretions.	Chronic appendicitis; two large concretions.
39.	5911	Retrocecal appendix with concretions.	Retrocecal tuberculous appendix.
40.	4345	Chronic gall-bladder disease.	Cholecystitis; many small stones.
41.	5282	Pathological gall-bladder.	Thickened gall-bladder with stones; cancer of liver.
42.	5484	Chronic gall-bladder with stones.	Cholecystitis with stones.
43.	8232	Surgical gall-bladder.	Gall-bladder and cystic duct filled with small stones.
44.	9293	Chronic appendicitis.	Chronic appendicitis.
45.	8309	Cancer of stomach and colon.	Confirmed.
46.	8241	Obstruction at valve.	Chronic appendicitis with Jackson veil.
47.	8493	Chronic appendicitis; duodenal ulcer.	Chronic appendicitis and veil; old duodenal ulcer.
48.	8818	Chronic appendicitis.	Appendix buried in adhesions.
49.	9977	Tuberculous colon.	Tuberculous colitis, appendicitis and peritonitis.
50.	6909	Tender cecum and appendix, probably tuberculous.	Appendicitis,—not tuberculous.
51.	6471	Chronic appendicitis, with concretion and adhesion.	Confirmed by operation.
52.	6265	Tender, adherent appendix perforation shadow.	Subacute appendicitis; perforation pocket.
53.	4790	Negative.	Confirmed by autopsy after accidental death.

TABLE VII *(continued)*

CASE	*Serial X-ray*	*X-ray findings*	*Operative findings.*
54.	4584	Ileo-cecal adhesions and Jackson veil.	Confirmed; bowel obstruction 4 days later.
55.	4391	Chronic appendicitis and colitis.	Acute appendicitis on chronic base.
56.	4312	Appendix normal.	Confirmed by operation for pelvic pathology.
57.	4295	Chronic appendicitis.	Confirmed by operation.
58.	3370	Chronic appendicitis.	Acute appendicitis on chronic base, several weeks later.
59.	3241	Small pathologic appendix.	Chronic appendicitis with acute area.
60.	9311	Chronic appendicitis with concretion.	Confirmed by operation.
61.	5710	Chronic appendicitis with ileo-cecal adhesions.	Confirmed by operation.
62.	6520	Chronic appendicitis.	Confirmed by operation.
63.	4436	Retrocecal adherent appendix.	Confirmed by operation.
64.	4445	Surgical appendix, adherent in pelvis.	Confirmed by operation.
65.	4261	Adherent, chronic appendix.	Acute appendicitis on chronic base.
66.	3740	Adhesions of colon.	Confirmed by operation.
67.	3483	Adhesions of colon.	Confirmed by operation.
68.	3788	Negative gall-bladder.	Confirmed by exploration.
69.	3790	Adherent, chronic appendix.	Acute appendicitis on chronic base.
70.	2747	Pathologic appendix, kinked and adherent.	Subacute appendicitis.
71.	3069	Negative cecum and appendix.	Confirmed by pelvic operation.
72.	3425	Pathological gall-bladder, probably with stones.	Dense adhesions about old gall-bladder drainage operation.
73.	9143	Pathology in cecal region probably from old appendix disease.	Chronic appendicitis; tuberculosis of tubes and ovaries.
74.	8195	Typhlitis and colitis.	Chronic appendicitis; adhesions.
75.	6535	Cecum adherent in pelvis. Duodenal ulcer (?)	Acute appendicitis, later; stomach not examined.
76.	5365	Jackson veil; chronic appendicitis.	Adhesions; chronic appendicitis.
77.	5018	Pathologic appendix; gall-bladder disease (?)	Chronic appendicitis.
78.	4101	Adhesions cecal region and along transverse colon.	Adhesions of omentum and colon to old operation scar.
79.	3979	Chronic appendicitis.	Chronic appendicitis.
80.	3820	Chronic appendicitis.	Chronic appendicitis.
81.	3464	Chronic appendicitis with concretions.	Chronic appendicitis.
92.	7621	Gastric ulcer; obstruction.	Gastric ulcer.
83.	5848	Pathologic appendix.	Chronic appendicitis.
84.		Ulcer of duodenum.	Duodenal ulcer; cancer of liver.

TABLE VII *(continued)*

Case	*Serial X-ray*	*X-ray findings*	*Operative findings.*
85.	4816	Negative.	No organic lesions; ptosis.
86.	4599	Chronic gall-bladder and appendix disease.	Chronic appendicitis; gall-bladder not inspected.
87.	3332	Undetermined pathology in upper right, involving pylorus, duodenum and colon.	Pyloric ulcer with stenosis and extensive adhesions.
88.	3141	Negative except stasis.	No organic lesions.
89.	3073	Chronic gall-bladder disease.	Chronic cholecystitis.
90.	1036	Obstruction, hernia or intestinal fistula.	Hernia with obstruction by twisting of sigmoid.
91.	2231	Ileocecal and colon adhesions.	Adhesions with partial obstruction.
92.	10010	Pyloric ulcer.	Pyloric ulcer; chronic gall-bladder disease; pancreatitis; chronic appendicitis.
93.	9745	Pyloric ulcer.	Pyloric ulcer.
94.	9278	Pyloric ulcer.	Pyloric ulcer.
95.	8860	Advanced cancer of stomach. Metastasis in lung.	Confirmed by operation and death from lung involvement.
96.	8004	Duodenal ulcer.	Duodenal ulcer.
97.	7978	Stomach ulcer.	Large ulcer lesser curvature.
98.	9826	Chronic appendicitis.	Chronic appendicitis.
99.	9717	Chronic appendix and gall-bladder disease.	Chronic appendicitis and cholecystitis with adhesions.
100.	9714	Chronic appendicitis.	Chronic appendicitis.
101.	8695	Pathologic gall-bladder.	Chronic gall-bladder and appendix disease.
102.	8356	Ileo-cecal adhesions.	Cecum adherent in pelvis.
103.	8240	Gall-stones.	Chronic gall-bladder disease with stones.
104.	8092	Pyloric ulcer.	Chronic pyloric ulcer with stenosis.
105.	8034	Chronic appendicitis.	Subacute appendicitis.
106.	6984	Early cancer of stomach.	Large pyloric ulcer with obstruction. No pathological examination.
107.	6818	Chronic appendicitis.	Chronic appendicitis.
108.	6770	Pyloric ulcer.	Ulcer of stomach.
109.	5266	Chronic retrocecal appendix.	Chronic appendicitis; retrocecal.
110.	4556	Stomach ulcer.	Pyloric ulcer; adhesions to myoma of uterus.
111.	4085	Cancer of stomach.	Advanced cancer posterior wall of stomach.
112.	3805	Advanced cancer of stomach.	Advanced stomach cancer.
113.	3423	Tuberculous appendix.	Chronic appendicitis; tuberculous.

TABLE VII *(continued)*

CASE	*Serial X-ray*	*X-ray findings*	*Operative findings.*
114.	2939	Gall-stones; pyloric ulcer; chronic appendicitis.	Gall-stones; pyloric adhesions. Appendix not removed.
115.	2284	Degenerating ulcer or early cancer.	Cancer of pylorus; resected.
116.	1974	Duodenal diverticulum.	Fistulous tract between duodenum and gall-bladder, with one stone in gall-bladder.
117.	1803	Gall-bladder disease.	Chronic cholecystitis.
118.	9059	Gall-stones and adhesions. Cecum not examined.	Gall-stones and chronic appendicitis.
119.	10052	Chronic appendicitis.	Chronic appendicitis.
120.	10027	Pyloric ulcer; Lane kink.	Right oblique hernia and appendicitis. Stomach not examined.
121.	9928	Chronic appendicitis.	Chronic appendicitis.
122.	9900	Obstruction at valve.	Chronic appendicitis with adhesions.
123.	9674	Appendix involvement.	Adhesions of cecum to right tube; both tubes attached to abdominal wall by previous operator.
124.	9601	Chronic appendicitis.	Chronic appendicitis.
125.	8141	Chronic appendicitis.	Chronic appendicitis.
126.	3470	Tuberculosis of cecum and ascending colon.	Tuberculous destruction of cecum and part of ascending colon.
127.	3353	Chronic appendix disease with extensive adhesions.	Extensive adhesions requiring ileo-sigmoid-ostomy.
128.	4171	Chronic appendicitis.	Appendicitis with subphrenic abcess.
129.	3947	Gall-stones.	Gall-stones.
130.	3373	Cecum adherent in pelvis.	Chronic appendicitis with adhesions.
131.	3305	Gall-bladder and appendix disease.	Chronic cholecystitis and appendicitis.
132.	10301	Gall-bladder disease with small stone in common duct.	Chronic cholecystitis with medium size stone in common duct.
133.	1141	Pyloric ulcer.	Pyloric ulcer.
134.	9076	Large saddle ulcer or cancer of pylorus.	Carcinoma of stomach, resected.
135.	10191	Negative.	Pancreatitis with adhesions about common duct.
136.	5044	Cancer of sigmoid.	Annular cancer of sigmoid.
137.	4912	Retrocecal appendix.	Confirmed by operation.
138.	4663	Colon adhesions.	Confirmed by operation.
139.	1959	Chronic gall-bladder and appendix disease.	Confirmed by operation.
140.	3214	Chronic appendicitis; no ulcer.	Confirmed by operation.
141.	2940	Cancer of pylorus.	Confirmed.

Table VII *(continued)*

Case	Serial X-ray	*X-ray findings*	*Operative findings.*
142.	4726	Chronic gall-bladder disease.	
143.	4268	Chronic appendicitis and gall-bladder disease.	Confirmed by operation.
144	3238	Chronic gall-bladder disease; pyloric ulcer; ileo-cecal adhesions.	Confirmed by operation. Cholecystitis with stones.
145.	3285	Chronic gall-bladder disease; probably stones.	Chronic cholecystitis; no stones.
146.	3956	Chronic appendicitis adherent in pelvis.	Chronic appendicitis, adherent to right ovary.

It will be noticed that in 35 cases there was more or less disagreement between the *x*-ray and the operative findings, while in 111 of the 146 patients, the *x*-ray examinations correctly foretold the operative findings.

Of the 35 cases in which there was disagreement in the findings, the first 10 patients were only partially examined, the lesions being found, at operation, in organs not examined by the roentgen ray. The next 6 patients gave negative examinations for appendix disease, but were operated for acute appendicitis at later periods; these were either cases of chronic appendix disease with acute terminations, or the occurrence of acute appendicitis in them was merely coincidence. The next 7 cases gave *x*-ray evidences of ulcer, but at operation none was found by palpation; rather than enter, at this time, into the argument over the reliability of excluding ulcer by palpation, we shall class these cases as errors of the roentgenologist. The remaining 12 cases were clearly errors of the roentgenologist in his conclusions.

REFERENCES

1. Deaver. *J. Am. M. Assn.*, Vol. 72, 1583.
2. Leonard. *Am. J. Roentgenol.*, Nov., 1913.
3. Roberts. *J. Am. M. Assn.*, Vol. 73, p. 1511.
4. Davis. *Penn. M. J.*, April, 1912.
5. Editorial. *J. Am. M. Assn.*, Vol. 48, 801.
6. Cabot. Differential Diagnosis, Vol. 2, p. 253.
7. Bevan. *Surg. Clinics of Chicago*, April, 1919, 301.
8. Connell. *J. Am. M. Assn.*, Vol. 67, 335.
9. Williams and Slater. *Ann. Surg.*, Nov., 1919.
10. *J. Am. M. Assn.*, Aug. 24, 1913, p. 673.
11. Sonnenburg. "Therapie de Gegenwart," July, 1912, Abs. *J. Am. M. Assn.*
12. Richelot. *Bull. Acad. de Méd. Par.*, June 20, 1918. May, 1919. Abs. *J. Am. M. Assn.*
13. Schwartz. *Ann. de méd. et chi. inf.*, Par., March 15, 1910. Abs. *J. Am. M. Assn.*
14. Bastedo. *Am. J. M. Sc.*, July, 1911.
15. Bassler. *Am. J. M. Sc.*, Aug., 1913.
16. Pfeiffer. *Ann. Surg.*, April, 1915.
17. Aaron. *J. Am. M. Assn.*, Feb. 1, 1913, 350.
18. Jacobson. *Am. J. Dis. Women & Child.*, March, 1913.
19. Bistow. *Long Island M. J.*, April, 1908. Abs. *J. Am. M. Assn.*
20. Vivian. *Arizona M. J.*, Nov., 1915.
21. Mayo. *Surg. Gynec. & Obst.*, 1911, XII, 228.
22. Murphy. Clinical Talk.
23. Horsley. *J. Am. M. Assn.*, Vol. 57, 697.
24. Brewer. Quotation.
25. Moynihan. *Oxford Surgery.*
27. Stanton. *J. Am. M. Assn.*, May 20, 1911.
28. Lichty. *Penn. M. J.*, Jan. 1915.
29. Cheney. *Am. J. M. Sc.*, Oct., 1918.
30. Leede. *N. W. Med. J.*, Aug., 1915.
31. Wilms. Quotation.
32. Brown. *J. Am. M. Assn.*, Nov. 15, 1919, p. 1501.
33. Moschowitz. *Ann. Surg.*
34. McCarty. Collected Papers of Mayo Clinic, 1910.
35. Goltman. *J. Tenn. M. Assn.*, Dec., 1913.
36. George and Leonard. "Roentgen Diagnosis of Surgical Lesions of the Gastro-Intestinal Tract."

A CASE OF DIAPHRAGMATIC HERNIA WITHOUT SEVERE SYMPTOMS DISCOVERED ON ROUTINE X-RAY EXAMINATION OF CHEST

By HORACE JOHN HOWK, M.D., and JOHN A. HERRING, M.D.

Metropolitan Life Insurance Company Sanatorium

MT. MC GREGOR, N. Y.

THE great majority of the cases of diaphragmatic hernia have heretofore been reported by surgeons, who have found the condition in emergency operations, or by others who have found the condition at autopsy, Seibert,[5] who has made a thorough review of the literature, found that Leichtenstein had reported 250 cases, only 5 of which had been diagnosed before death. Diagnosis from the physical findings alone is difficult. The history of trauma followed by gastrointestinal symptons is only suggestive and certainly not specific, and only can a positive diagnosis be made from roentgenological findings.

Now that fluoroscopic and roentgenographic examination of the gastrointestinal tract is becoming more and more generally used we feel that diaphragmatic hernia will be more often diagnosed and cease to be a mere surgical curiosity.

Usually diaphragmatic hernia follows severe trauma, either severe blows, contusions, stab wounds, or even prolonged labor. The symptoms—pain, vomiting, signs of obstruction, etc., very soon follow the injury. Rarely, as in this case where there is no real obstruction, may the symptons be slight. All that this patient complained of was belching gas, bilious attacks, sour stomach and constipation.

There is no reason to believe that the diaphragm should not be the seat of hernia as well as other parts of the abdominal wall. Violence being the direct cause, any anatomical variation in the diaphragm may favor its establishment there.

Here the "paradoxic respiratory phenomena," the upward movement of the left diaphragm as the right moves down on deep inspiration, as described by Carman and Miller,[2] was doubtful. The fundus of the stomach was fixed within the thorax, its wall permanently held in a distended condition.

Case No. 1011. Mr. F. S. came to the Sanatorium complaining of a tickling cough, loss of weight and strength, indigestion, and constipation. No history of severe illness. The appetite of the patient is good; he is a moderate eater; eats meats, sweets and vegetables once a day. Teeth are in fair condition. He has suffered very much in the past with indigestion, nausea and vomiting; has pain in the stomach due to distention and is relieved by belching. Bowels are irregular and somewhat constipated.

When the patient was about thirteen years of age he was struck in the abdomen. He was unconscious for about fifteen minutes but had no other immediate after effects. About this time he began to have headaches which were migrainous in type. For the last twenty-five years these headaches and constipation have been persistent. The latter has been relieved by olive oil and hot water. Once every four or five days for the last twenty years he has had a heavy feeling in the stomach which comes on in the afternoon, gradually increases, and is aggravated by food. A physic relieves this condition. At times he vomits greenish, slimy water which also relieves him.

There is no shortness of breath or palpitation.

He has not been well since 1912, when sugar was found in his urine. Under proper diet this soon cleared up. Several exami-

nations here failed to reveal any sugar.

The physical examination, except for slight ptosis of the right kidney, tenderness on deep pressure over the appendix, and chest findings, was negative. There was broncho-vesicular breathing above the right clavicle, with a few fine dry râles after coughing. At left base in front there was moderate impairment, absent vocal resonance, and feeble breath sounds. At the right back, a few fine dry râles could be detected after cough at apex. At the left back, there was moderate impairment; feeble breath sounds and absent vocal resonance were noted below the level of the eighth cervical vertebra to the base.

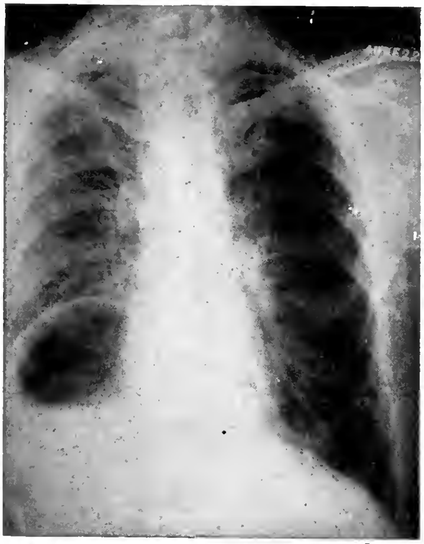


Fig. 1.

A routine x-ray examination of the chest (Fig. 1) disclosed it as normal for a man of his age, with the exception of the shadow in the lower left thorax.

This shadow at first was thought to be a pneumothorax, or possibly a diaphragmatic hernia. To make the differential diagnosis the patient was given a barium meal; the two-meal method was employed.

FLUOROSCOPIC EXAMINATION.

The patient is tall and slender; the intercostal angle is somewhat less than a right angle; he approaches the asthenic type.

Standing Position.—The upper thorax is negative; the lower right thorax is also negative. Occupying the lower left thorax there is an area of high light which extends up into the thorax from below as high as the third interspace in front and ninth rib behind. This area is bounded by a definite thin line extending from the spine almost to the lateral wall of the thorax. It is roughly pear-shaped in outline. On inspiration the right dome of the diaphragm moves down readily; the left cannot be made out with certainty. On the left side, on inspiration, there is definite movement of the splenic flexure upward, but the area of high light changes very little. It tilts somewhat and slightly flattens. This is suggestive of a "paradoxical respiratory phenomena.[3]" The shadow of the heart and lower bronchovascular tree can be seen through this area. In the lateral position this area is somewhat posterior to the heart.

Fig. 2.

The cecum, transversus and splenic flexure, except for high position, are normal. The splenic flexure lies very close to the area but is below it.

The esophageal function is normal. The barium enters the stomach just below the medial margin of this area of high light. It splashes upon its inner surface and drains

out immediately into the middle portion of the stomach. There is a definite constriction just below the fundus (as this area is now identified) between the upper and middle thirds of the stomach (Fig. 2) through which the barium trickles down into the pars pylorica. The stomach canalizes readily below the constriction. The greater curvature is on a level with the crests (Fig. 3). The cap is triangular and normal in outline. Pressure on the redundant pyloric antrum forces the barium back up through the constriction.

the diaphragm cannot be positively identified.

There was no retention. At the end of three hours the stomach was entirely empty and after twenty-four hours the gastrointestinal tract was practically empty.

From the above examination there is little doubt as to the condition found. The clear area in the lower left thorax is the fundus of the stomach, above the left diaphragm. It is probably fixed around its outer surface since it did not change its size or shape or collapse during any manipulation or change of the patient's position.

Fig. 3.

Fig. 4.

Dorsal Position.—In this position the area of high light is completely filled with barium. It is definitely pear-shaped in outline; the smaller end is about one inch from the spine.

Prone Position.—In this position the area is well filled, but the pear shape is not so apparent. The whole of the stomach lies to the left of the spine and its position from this point of observation has moved to upper part of abdomen. Contraction waves pass readily over the prepyloric region (Fig. 4). As the patient is gradually raised to an upright position the fundus empties, the level of the barium becomes horizontal and it can be seen to enter the prepyloric antrum below, through the constriction. The left dome of

Observations were made with the patient in all possible positions. Probably the opening in the diaphragm through which the stomach passes is just to the left of the hiatus esophagus.

The condition was at first thought to be congenital, but on more careful inquiry it was decided that it probably followed a blow on the abdomen when the patient was about thirteen years old.

REFERENCES

1. Balfour, D. C., 1916. *Ann. Surg.*, Phila. Jan.
2. Bevan, Arthur Dean., 1917. *Surg. Clin.*, Chicago, June.
3. Carman and Miller. "Roentgen Diagnosis of Diseases of the Alimentary Canal." Phila.: W. B. Saunders Company.
4. Mills, 1917. *Am. J. Roentgenol.*, April.
5. Siebert, Otto J., 1916. *Surg. Gynec. & Obst.*, Oct.

HERNIA OF THE DIAPHRAGM WITH A PORTION OF THE STOMACH IN THE THORACIC CAVITY

By WEBSTER W. BELDEN, M.D.

Late Capt. M. C., U. S. A., Roentgenologist, General Hospital 41

NEW YORK

PRIOR to the great war, cases of hernia of the diaphragm with either the stomach or colon or both passing into the thoracic cavity were a decided rarity. In fact, in 1908 the most recent text-books did not even mention the images furnished by this type of lesion. Barjon mentions a single case in which the diagnosis was doubtful—either pneumothorax with double pocket or a hernia of the stomach in the chest.

In addition, we have mentioned in a chapter by Patel and Jaboulay on hernias in "Nouveau Traité de Chirurgie de Le Deutre et Delbet," Paris, 1918, this type of lesion, and a case of congenital hernia of the diaphragm with the stomach in the thoracic cavity reported by Dr. L. T. LeWald of St. Luke's Hospital,, New York, in The American Journal of Roentgenology in 1917. Also one reported by Berti and Giavedoni in an article published in Milan in 1916.

Since the war, in addition to the case described by Jean Quinn and Legrain, which was revealed by autopsy, a case of diaphragmatic hernia of the stomach and transverse colon has been reported by Dr. Pierre Wairt in *Bull. de la Soc. de Chirurgie de Paris*, Vol. XLIII, No. 25, July, 1917. There have also been two observations of P. Lecine in the *Journal de Chirurgie*, Vol. XIV, No. 3. All these depended upon the radioscopic examination.

Another case has since been reported in the *Journal of the American Medical Association*, July 26, 1919. There are in addition two cases, which have been reported by Dr. P. Aimé and Dr. J. Solomon, the article appearing in The American Journal of Roentgenology, August 1919, also a case by Andrew J. Grant in the *British Med. Jour.*, Sept. 27, 1919.

There are two cases which were observed by Major Martin, and the anatomical specimens are in the Museum of the Val de Grace.

Most writers agree that the roentgen examination is diagnostic in these cases, but granting for the sake of argument that the above is claiming too much, and that the clinical signs and symptoms are sufficient for the diagnosis, still all are agreed that the roentgenoscopic examination gives the clinician a factor of certainly that he should never neglect.

It must be admitted that the term "Hernia" which is in general use for this lesion is to use Lecine's words "partially exact." He prefers "transdiaphragmatic interpleural evisceration" because there is no hernial sac. However, the term is used generally and with good authority to such organs as the brain.

The mechanical cause, namely: The difference between the inter-abdominal and the inter-thoracic pressure in inspiration or in caughing, is sufficient to cause the passage of the abdominal viscera to a certain extent into the chest, when the diaphragm has either a traumatic or congenital break in its continuity. The stomach is the abdominal organ most commonly associated with hernia.

The clinical signs described by Patel and Jaboulay are dyspeptic symptoms, vomiting, angioid pains, tympany on percussion, borborygmus and gurgling with auscultation. These symptoms are usually vague or incomplete, a number being very obscure and showing no clinical symptoms, being autopsy findings.

This was somewhat true in the case which the writer wishes to report.

Case B. Cook. Second Anti-Aircraft Bat. was admitted from Evacuation Hospital to French Hospital No. 46 with a gunshot wound in his left chest posteriorly and multiple wounds in his left thigh. On December 5, 1918, patient was admitted to Base Hospital No. 1. The gunshot wound in his left chest was healed. A foreign body was removed by a posterior incision of the chest and the operative wound healed rapidly and without complication. At this time expansion of lung resonance and breath sounds apparently normal. All wounds of thigh partly healed. Patient slightly jaundiced.

On December 18th, patient complained of weakness. Heart action rapid and examination of the chest showed function of the left lower lobe considerably impaired from the wound. On December 22, 1918, patient weak and complaining of pain in epigastric region. Temperature 99 degrees. On December 27, patient to be evacuated to Base Hospital, free of hernia, no evidence of uremia. December 30, entered Base Hospital No. 100, Savonary, France, in weak condition; complaining of heartburn and vomiting. December 30, condition slightly improved. Still unable to retain nourishment. Vomiting after meals, usually one to one and one-half hours. Apparent pallor, some emaciation, not jaundiced.

January 28, 1919, general condition improved. Still vomits and has epigastric distress. Ready for evacuation to United States.

Admitted to General Hospital No. 41, New York, February 28, 1919.

Physical examination reveals scar extending diagonally from below, upward from posterior axillary line to within 10 cm. of 6th dorsal spine. Breath sounds clear and frequently absent below scar on left side. Here also note on percussion is dull and vocal fremitus absent. Abdomen scaphoid. Tenderness in epigastrium and right hypochondriac region. Patient shows pallor; no jaundice; is emaciated and complains of heartburn and constant pain in abdomen. Vomits after every meal a portion of the meal. X-ray examination of the chest requested.

February 23, 1919, when the roentgen examination was made the patient was first examined by means of a plate while in the prone position, the negative showing a resection of about 7 cm. of the tenth rib posteriorly. In this region, extending from the lower border of the eighth rib was a large rounded mass, showing a diffuse hazy increase in density, but a clear area was noted in the costodiaphragmatic angle. The upper border of this area had a definite sharply marked outline which was convex. (Fig. 1.)

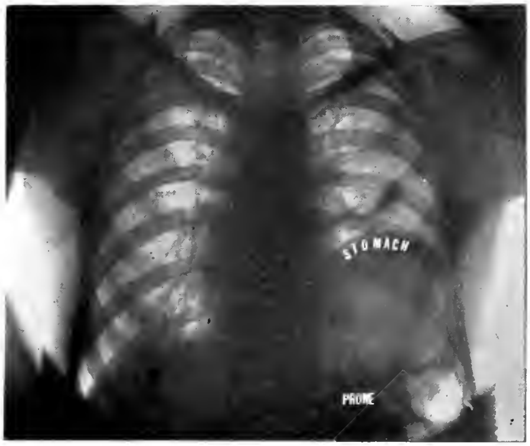


Fig. 1. Shows Shadow in Chest which Proved to be Pouch of Stomach Above Diaphragm.

When fluoroscoped in the prone position these findings were confirmed. This of course suggested the possibility of encapsulated fluid in the lower portion of the left chest. The patient was then fluoroscoped in the erect position and what previously had appeared to be a sharp outline of the upper border of the area of increased density, was seen to be a definite line convex upward, and below this line a very sharp clearly marked fluid level was seen. This fluid was seen to pulsate with the pulsation of the heart. The fluid line changed with a change of position of the patient and continued to transmit the cardiac pulsations. The cardiac shadow was slightly displaced to the right. The left lung was forced upward and contained less air than the right. On deep inspiration there was

a definite lagging of the left side of the chest; the interspaces did not change to as great a degree on the left as on the right, and the convex line in the lower portion of

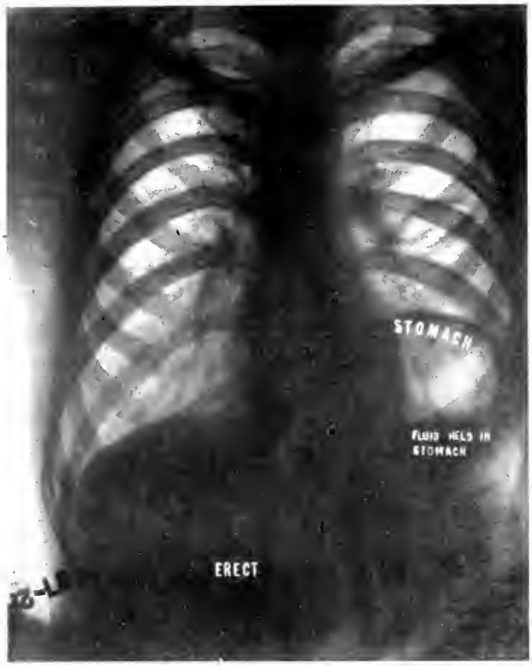


FIG. 2. SHOWS PATIENT STANDING WITH UPPER BORDER OF STOMACH AS CONVEX LINE AND A FLUID RETAINED IN STOMACH.

the chest remained stationary. This convex line appeared to be about the level of the eighth rib. A plate was then made with the patient erect and these findings confirmed. (Fig. 2.)

The patient was then fluoroscoped while drinking Barium Sulphate in buttermilk. The opaque meal passed down the esophagus normally, passing through the cardia and entering the stomach in the median line. As the barium filled the stomach a sacculated shadow appeared to the left of the median line. This shadow of the barium did not fill the stomach in the usual position in the abdomen but formed a pouch to the left of the median line and then passed upward through a constricted portion. (Fig. 3.)

As the patient continued to drink the Barium the pouch in the abdomen grew larger and the opaque substance was seen to pass more readily through the constricted portion and then fill another pouch above the first. As this took place the fluid line in the thorax was seen to rise definitely until it merged with the convex shadow in the left chest. (Fig. 4.)

Twenty-four hours after this examination all of the barium had passed out of the stomach and only a small amount remained in the descending colon and rectum. The examination of the chest at this time showed that the upper pouch of the stomach still contained barium and revealed a fluid level still present in the chest; the findings being exactly similar to those seen in the previous examination of the chest with the patient in erect position, as shown in Fig. 2.

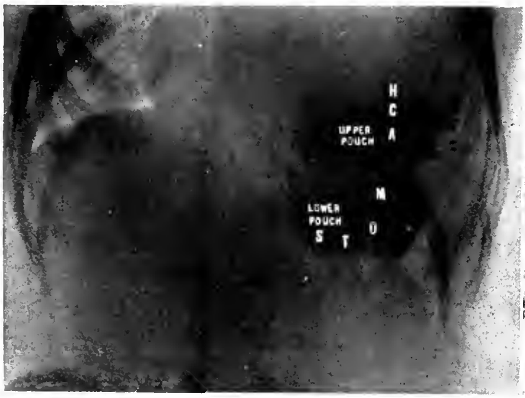


FIG. 3. SHOWS BOTH POUCHES OF STOMACH FILLED, UPPER ONE BEING ABOVE THE DIAPHRAGM AND ALSO THE CONSTRICTED PORTION IN THE DIAPHRAGM OPENING.

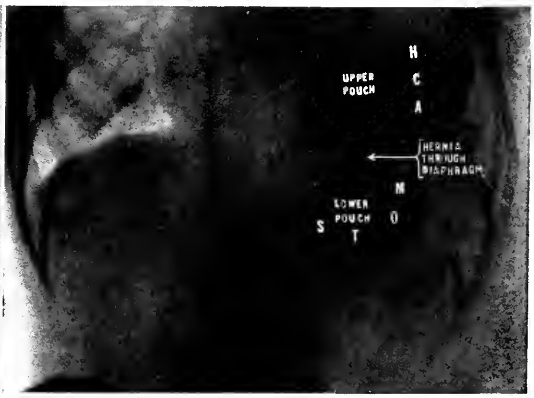


FIG. 4. SHOWS LOWER POUCH FILLED AND BEGINNING FILLING OF UPPER POUCH.

From these findings the diagnosis was made of hernia of the diaphragm with a

portion of the stomach in the thoracic cavity.

These observations show the tremendous importance of a roentgen examination, not only from a diagnostic standpoint, but also to alleviate the suffering of the patient in all such obscure stomach and chest conditions, and to give the surgeon definite information for operative intervention.

The writer cannot be too emphatic on this point and agrees heartily with Drs. Aimé and Solomon in their observations published in The American Journal of Roentgenology, August, 1919. The interesting pathological findings are that wounds of the diaphragm show a necessity for surgical intervention, having no tendency to spontaneous healing. This is proven by the fact that this patient had been under observation for three months without change in his condition. It also proves that the clinical signs and symptoms of hernia of the diaphragm and the clinical methods of diagnosis are at the best very indefinite.

A report of one case would certainly not be of value in proving the above, but when taken into consideration along with the cases reported by other roentgenologists it is confirmatory, especially in view of the fact that several cases have since been reported which are exactly similar as to clinical signs and proving that spontaneous healing never occurs any more than would a case of femoral or inguinal hernia.

MANUFACTURE OF THE COOLIDGE X-RAY TUBE

By R. C. ROBINSON and C. N. MOORE

Research Laboratory, General Electric Company

SCHENECTADY, N. Y.

IT was the privilege of the General Electric Company to entertain the members of THE AMERICAN ROENTGEN RAY SOCIETY and guests during the meeting at Saratoga Springs in September, 1919, and to show them by a trip through the laboratory and factory the various processes involved in the manufacture of the Coolidge *x*-ray tube. It is obviously impossible to convey by a written description the impressions gained by a personal inspection of this sort, but for the benefit of those who were unable to be present at that time, the following brief record is offered.

The Coolidge *x*-ray tube is now manufactured in two different types, Universal and Radiator. (For a description of these and their mode of operation, the reader is referred to various publications which have been issued during recent years.[1])

The process of manufacture of this tube may be divided into the following steps:

1. Preparation of the Metal Parts.
2. Assembly of the X-Ray Tube.
3. Exhaust of the Assembled Tube.
4. Testing X-Ray Tubes.

I. PREPARATION OF THE METAL PARTS.

TUNGSTON.—Wrought tungsten is one of the essential metals entering into the construction of the anode and cathode of all of the above types of Coolidge tube. The complicated process required for the production of this metal was evolved in the Research Laboratory in connection with the incandescent lamp development. The steps involved are as follows:

(a) *Purification of Tungstic Oxide.* Commercially pure tungstic oxide powder is dissolved in strong aqueous ammonia, and the solution is filtered. Pure tungstic oxide is then very carefully precipitated from this solution by the addition of hydrochloric acid. This yellow precipitate is filtered, very thoroughly washed, dried in oven at about 300° C., and finally sifted through 40 mesh sieves. A very high degree of purity is required in the oxide in order that the tungsten metal produced from it may be workable in the later stages of the process.

(b) *Reduction of Tungstic Oxide.*—The purified tungstic oxide is reduced to tungsten metal powder by means of hydrogen in a battery of specially designed reduction furnace (Fig. 1). These furnaces consist of electrically heated porcelain tubes in which a definite amount of the oxide is placed, and through which dried and purified hydrogen is passed at a definite rate. The temperature of the furnace is very gradually raised and maintained at a maximum until the reduction is complete. The metal is then allowed to cool in the atmosphere of hydrogen before removal from the furnace. The whole operation requires about twenty-two hours, and every step must be very carefully regulated in order that the resulting metal shall have the necessary characteristics.

(c) *Pressing Rods of Tungsten Powder.*—The resulting metallic powder is pressed into rods in the following manner (Fig. 2). A weighed amount of the dry tungsten powder is formed by hydraulic pressure in a specially designed mold into a rod 11 inches

[1] A Powerful Roentgen Ray Tube with a Pure Electron Discharge. *Physical Review*, Vol. 2, No. 6, December, 1913.

A New Radiator Type of Hot Cathode Roentgen Ray Tube. *General Electric Review*, January, 1918.

The Radiator Type of Tube. AM. J. ROENTGENOL., Vol. 6, No. 4, April, 1919.

Apparatus for Portable Radiography. *Journal of Roentgenology*, July, 1919.

Coolidge X-Ray Tube. Instruction Book 9136A, General Electric Company, April, 1919.

long, 1 inch wide and 1 inch thick. In the operation, a force of over 100,000 pounds is applied to the plunger of the mold. The pressed rod thus produced is too fragile to pick up, but is carefully transferred to a temporary support, consisting of molybdenum, the sister element of tungsten. On this support, the tungsten rod is heated three-quarters of an hour at about 1600°C. in an electrically heated tube furnace, and is protected from oxidation at this temperature by hydrogen gas, which is continually passing through the furnace. In this firing operation, the rod shrinks from 11 inches to 10½ inches in length and becomes strong enough to be handled.

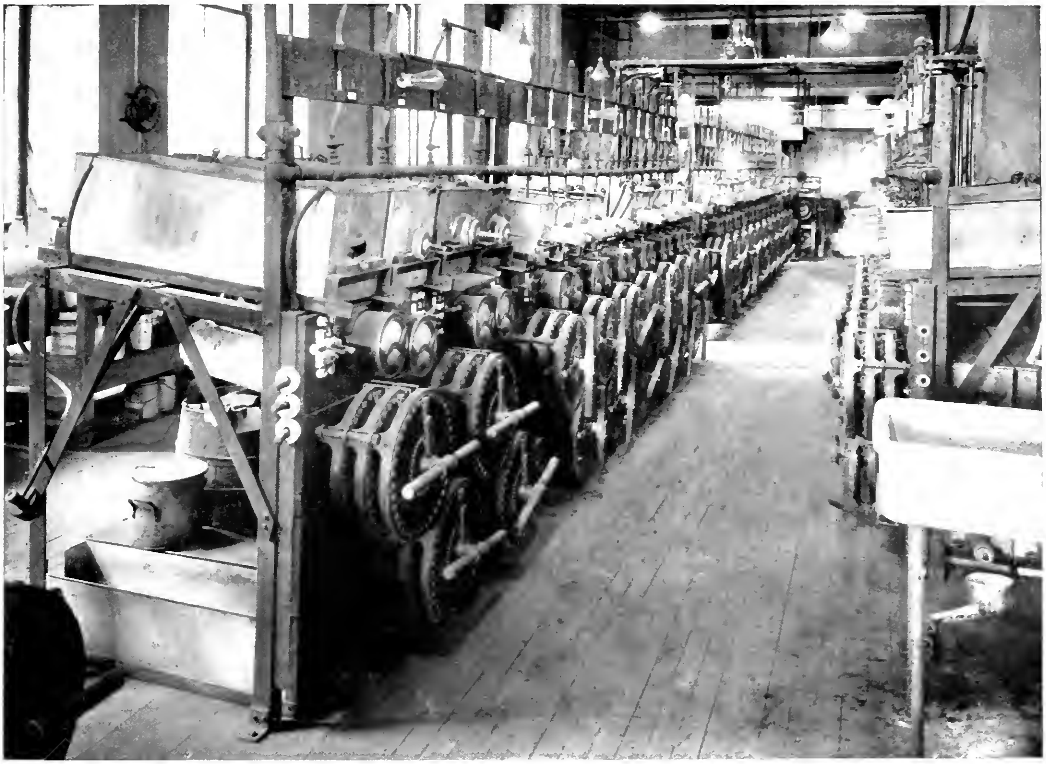


FIG. 1. FURNACES FOR REDUCING TUNGSTIC OXIDE.

(d) *High Temperature Sintering of Tungsten Rods.*—A tungsten rod pressed and fired as just described is next clamped in an upright position in a so-called "treating bottle" in which it is heated close to its melting point for about an hour by the passage of a current of 10,000 amperes at 6 volts (60 KW). (Fig. 3.) In this "treating bottle" the rod is protected from oxidation by a steadily maintained current of hydrogen gas. The interesting features of the treating bottle are the upper water-cooled clamp, the heavy copper lower clamp swimming in a water-cooled pool of mercury which leaves the rod free to shrink, and the mercury seal which prevents air from reaching the interior of the bottle.

As it comes from the "treating bottle," the tungsten rod is very dense, is brittle when cold, and gives a fracture resembling steel.

(e) *Hot Swaging of Large Tungsten Rods.*—Tungsten cannot be worked mechanically while cold. It is so hard that it cannot be machined by sharp edge tools, but has to be brought into desired shapes by high temperature hammering or cold grinding.

The rough anode head for the Universal

tube is formed from a sintered tungsten rod in a swaging machine, which is a nicely controlled high speed hammer used in this case to reduce, by successive operations, the diameter of the tungsten rod. The rod is heated to about 1600° C. in an atmosphere of hydrogen gas in an electric furnace, and is then rapidly passed through the swaging machine. In this operation the diameter of the rod is reduced 10 per cent. The rod is then re-heated in the furnace and is ready for the next pair of swaging dies, which will again reduce its diameter by 10 per cent. When the rod is at the required diameter for the head of the anode, the end of the rod only is swaged down to form the taper and straight portion to which the molybdenum stem is attached. After rough grinding to approximate size and shape, the anode head and molybdenum stem are swaged together. The assembly is completed by the addition of an iron collar and a thin metal tube and the finished anode is then polished and very carefully cleaned.

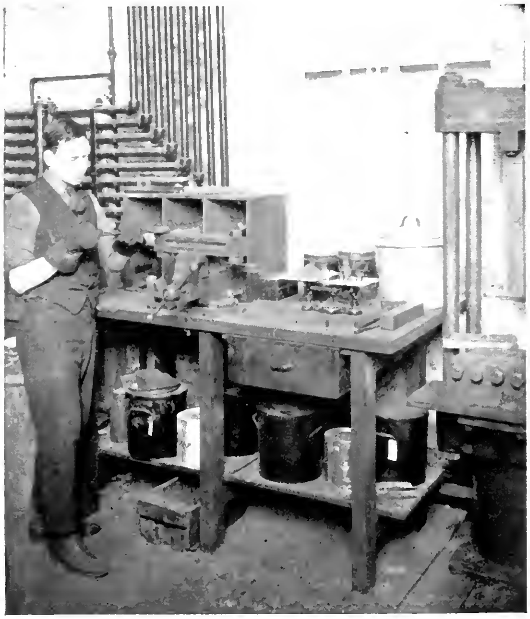


FIG. 2. MOLD AND HYDRAULIC PRESS FOR MAKING RODS FROM TUNGSTEN AND MOLYBDENUM POWDER. The operator is removing a rod from the mold after pressing in the hydraulic press at the right.

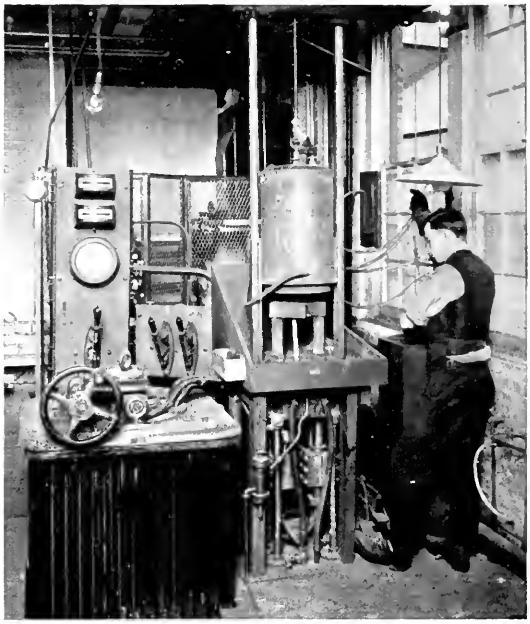


FIG. 3. TREATING BOTTLE AND TRANSFORMER FOR SINTERING TUNGSTEN AND MOLYBDENUM RODS. The operator is lowering the bottle over the rod which is held in place by the heavy copper clamp.

(f) *Tungsten Wire for Cathode Filaments.*—The tungsten wire used in making the filament for the cathode is produced in a similar manner, the rod being reduced in size in the swaging machine until it may be hot drawn to the required size of wire through diamond dies.

MOLYBDENUM.—Wrought molybdenum is very much like wrought tungsten, but differs from it in that it can be machined while cold. Also for a given amount of mechanical working, it is stronger than wrought tungsten. Various parts of the cathode and anode structures are made from it. Its preparation is similar to that of wrought tungsten.

COPPER-BACKED TUNGSTEN ANODES.—The anodes for radiator type tubes are made by casting specially purified (boronized) copper around a carefully cleaned tungsten disc in a vacuum.[2] Copper and tungsten do

[2] COOLIDGE. Metallic Tungsten and Some of Its Applications. *Trans. Am. Inst. Elect. Engrs.*, 31 (1), 1219-28, 1912.

not alloy with one another, but under the conditions employed, the melted copper wets the tungsten and adheres firmly to it when it solidifies. This process assures good thermal conductivity between the tungsten and the copper. The finished anode heads are electrically welded to a rod of copper which is to extend out through the anode arm of the tube and support the radiator. The platinum or alloy sleeve by means of which the seal between anode and glass is made is silver-soldered to the copper rod.

CATHODE ASSEMBLY.

(a) *Preparation of Cathode Spirals.* For all cathode filaments, tungsten wire of 0.0085 inch diameter is used. The first operation in making a filament spiral is the winding of the wire on a conical mandrel of special tungsten steel. Before the spiral is removed from its mandrel, it is given an anneal in hydrogen in an electric furnace. Conical spirals thus prepared are next clamped in molybdenum forms and heated in an electric furnace to a temperature of 1600°C. in an atmosphere of hydrogen gas. This forming of spirals is carried out to give three different shapes of filament which are necessary to produce the various sizes of focal spot (Fig. 4).

(b) *Assembly of Cathodes.*—The assembly of the cathode calls for very delicate manipulative work. As shown in Fig. 5, many of the parts are small; and in order to obtain the desired size and distribution of energy over the focal spot, the relative positions and shapes of these various parts must be nicely regulated. The tungsten terminals of the spirals in assembled cathodes are welded in place by arcing in hydrogen gas. One weld is made on the cathode cup and the other on the metal leading-in wire. This operation is carried out in an inverted glass bell jar through which is passing a stream of hydrogen.

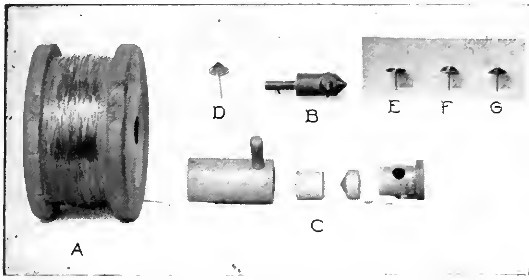


FIG. 4. VARIOUS STEPS IN THE FORMING OF FILAMENTS FOR CATHODES. *A*, spool of tungsten wire; *B*, Mandrel with filament wound on it; *C*, form (unassembled) for high firing of filament; *D*, low fired filament; *E*, fine focus filament after firing in form; *F*, medium focus filament; *G*, broad focus filament.

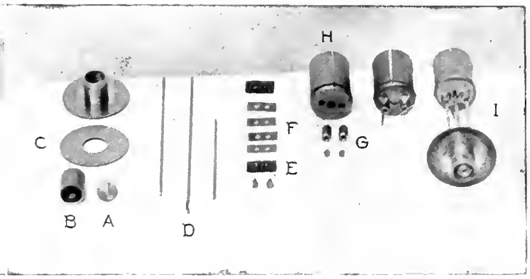


FIG. 5. PARTS OF CATHODE OF UNIVERSAL TYPE TUBE AND VARIOUS STAGES OF ASSEMBLY. *A*, filament; *B*, molybdenum tube; *C*, molybdenum disc; *D*, leads; *E*, metal clamp; *F*, mica washers; *G*, bushings; *H*, support tube; *I*, assembly.

VACUUM FIRING OF METAL PARTS.—All metal parts before being mounted in an *x*-ray tube are fired in a quartz tube vacuum furnace at 900°C. for about an hour, and are allowed to cool down in a vacuum so as to prevent oxidation (Fig. 6). The purpose of this firing is to render the parts perfectly clean and to remove partially the occluded gases and thus reduce the time required in the exhaust of the tube.

2. ASSEMBLY OF *x*-RAY TUBE.

The bulbs and glass parts used in the tube are blown in molds at the glass factory and are therefore of uniform shape and quality.

The operation of assembling these glass parts and the metal parts prepared as above is carried on by girls with the help of glass-blowing machines, one of which is shown in Fig. 7. These are essentially lathes in which

the two glass parts to be joined are clamped in separate chucks which are geared together so as to rotate at the same speed. Fires are provided for melting the glass, and compressed air, controlled by valves, for blowing.

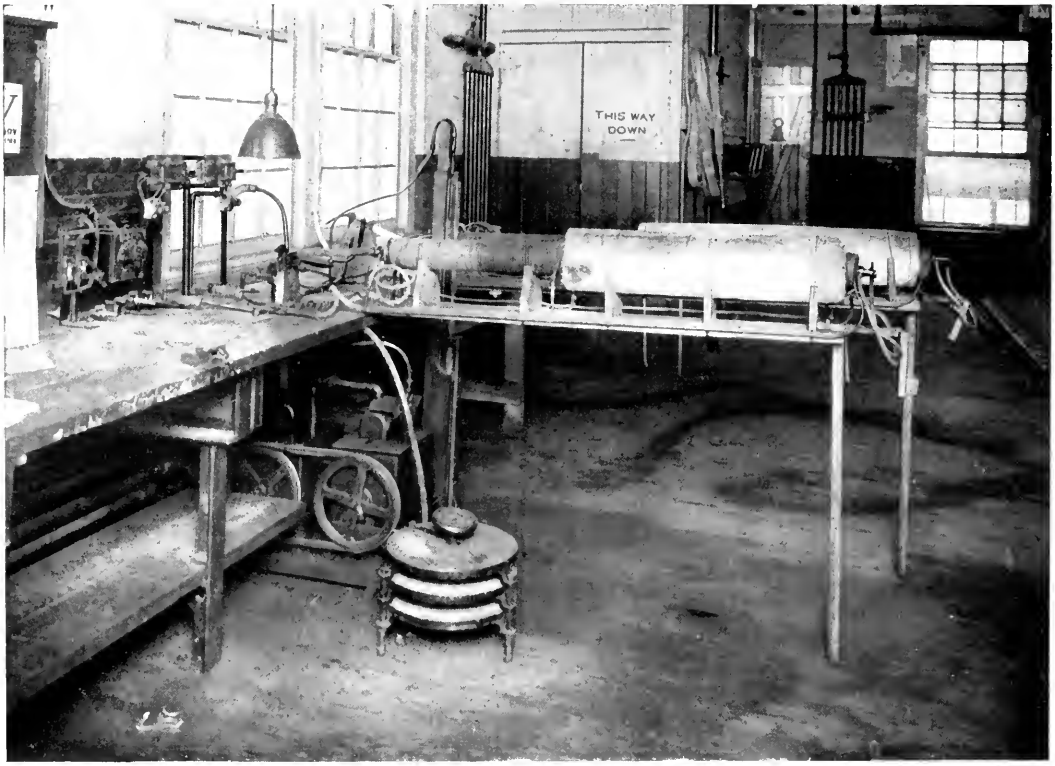


FIG. 6. VACUUM FURNACE USED FOR FIRING METAL PARTS OF X-RAY TUBES.

The various steps involved in the assembly of the tube are as follows:

a. Sealing on exhaust tube.
b. Sealing on cathode side arm.
c. Sealing in anode support tube.
d. Sealing in anode.
e. Sealing in cathode.

A separate machine is used for each of these operations, each one being slightly different from the others.

There are a few operations, especially in the assembly of the radiator type tubes, which require the services of skilled glass-blowers.

3. EXHAUST OF THE FINISHED TUBE.

The Coolidge *x*-ray tube requires a very high degree of vacuum for successful operation, approximately one ten-millionth of an atmosphere. In order to obtain this high vacuum, an elaborate exhaust system is necessary, as shown in Fig. 8. This consists of a series of three mechanical pumps, one condensation pump, and a trap surrounded by liquid air.

The *x*-ray tube to be exhausted is sealed directly to the glass tube coming from the liquid air trap. It is supported inside of a large oven, which is arranged with electric heaters for heating the tube during the first stage of the exhaust, and so constructed as to provide ample *x*-ray protection for the operators (Fig. 9).

The first operation in the exhaust consists of heating the tube to about 400°C. for three-quarters of an hour. This heating removes water-vapor, carbon dioxide and other gases from the glass and metal parts.

After cooling, the tube is connected to an *x*-ray machine and operated as an *x*-ray tube. For the early stages of the exhaust, a

machine is used which is so arranged that it operates automatically, passing just enough current through the tube to drive out the gas at a rate at which it can be removed by the exhaust system. The final stages are carried

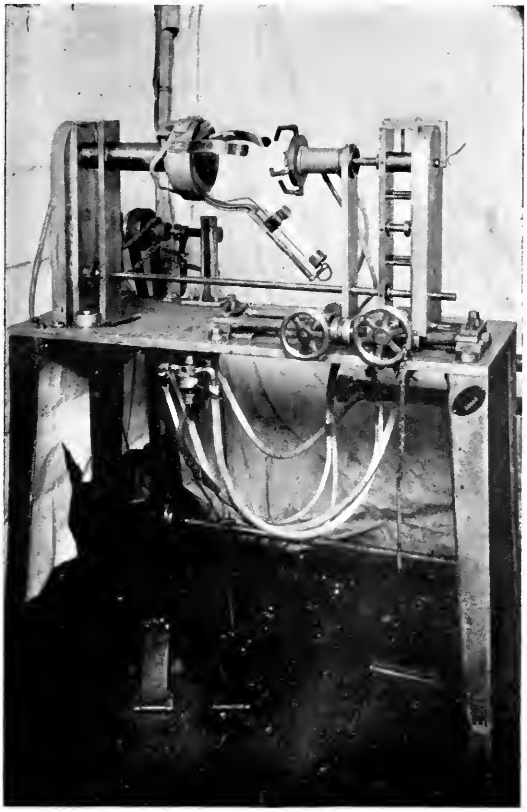


Fig. 7. Glass-Blowing Machine.

out on a regular interrupterless machine, and the operation has to be very carefully regulated by trained operators. As the vacuum improves, the potential applied to the tube is constantly raised. The operation is continued until all signs of gas, that is, appreciable green fluorescence in the bulb, have disappeared and the tube is backing up a 10 inch parallel spark gap and the anode is at an intense white heat. The whole operation requires about one and a half to two hours' time.

The above description applies to the exhaust of the Universal type of tube. The anode in the radiator types of tube cannot be heated as hot because of the low melting point of copper. The exhaust is carried out with the tubes connected to high tension transformers without mechanical rectifiers and requires a considerably longer time than the Universal type.

4. TESTING *x*-RAY TUBES.

A. Universal Type. *When the exhaust* of the tube is completed, it is sealed off from the exhaust system. After an interval of at least twenty-four hours, it is given a preliminary test. This consists of running at a six inch parallel spark gap with sufficient current through the tube to heat the anode to a white heat, and then increasing the gap to ten inches. Tubes which show appreciable green fluorescence in the bulb are rejected and must be re-exhausted. Tubes which pass the first test are provided with anode and cathode bases, and after a certain time-interval given a second test which is a duplicate of the first. A third test is made just before shipment.

B. Radiator Type. (a) *10 Milliampere Tube.*—The test of the radiator type tube differs considerably from that of the Universal type. The preliminary test of the 10 milliampere tube consists in running for two minutes with 5 milliamperes at 40 KV., one minute with 5 milliamperes at 50 KV., and one minute with 10 milliamperes at 60 KV.

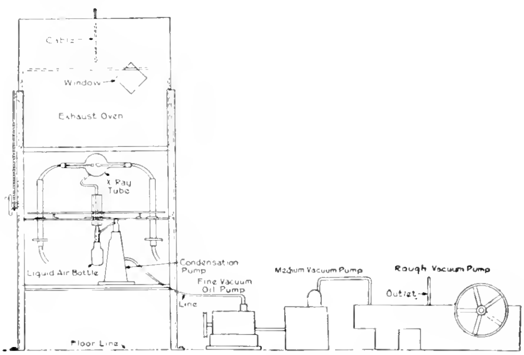


Fig. 8. Oven and Exhaust System for Exhausting X-Ray Tubes.

After basing and after a certain time-interval, the tube is given the second test, which consists of running continuously for two minutes at 10 milliamperes and 60 KV.

Tubes are rejected which show appreciable green fluorescence in the bulb.

During the two minute run, three pinhole camera focal-spot pictures of the tube are made on a dental film. Two of these are made with differently timed short exposures and show the distribution of the energy over the focal spot. The third is made with a longer exposure to show the total area of the focal spot. This third focal-spot picture is very carefully measured along two diameters, and if the size does not fall within certain very narrow limits, the tube is rejected.

(b) *30 Milliampere Tube.*—The preliminary test is the same as that for the 10 milliampere tube. The second test consists of a twenty-five second run with 30 milliamperes and 60 KV. Focal spot pictures are taken during this run.

(c) *Dental Tube.*—The first test is similar to that of the 10 milliampere tube except that the highest voltage used is 50 KV. The second test consists of a two minute run with 10 milliamperes at 50 KV., during which time focal spot pictures are made.

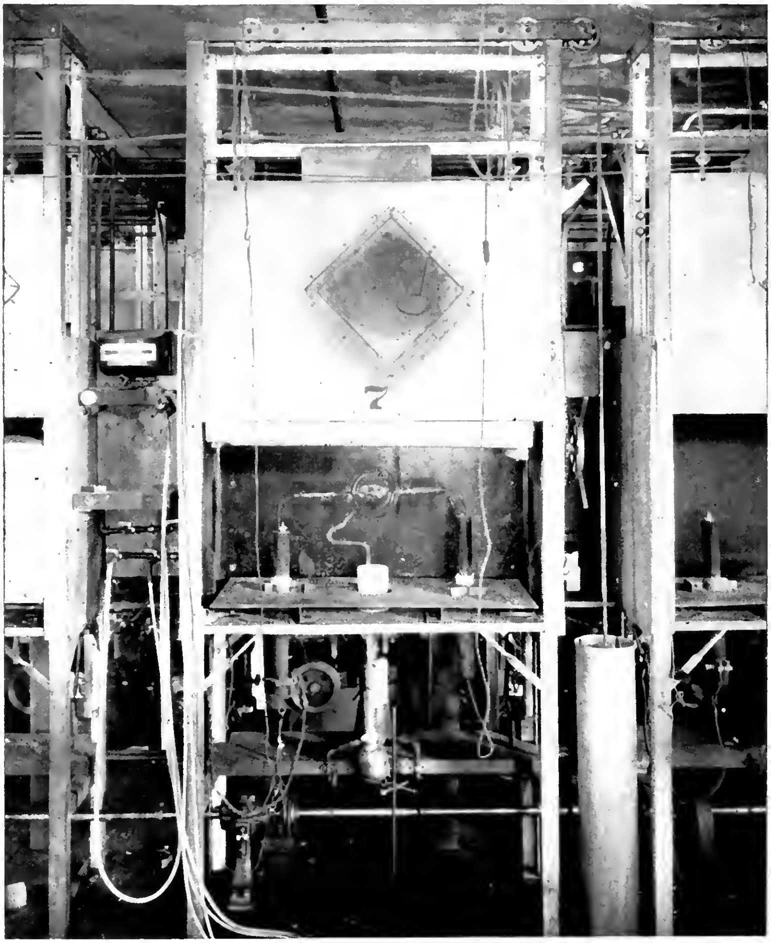


Fig. 9. Exhaust Oven for Universal Type Tube with Tube in Position.

(d) *Portable Tube.*—The first and second tests consist of running the tube on the portable outfit for fifty-five-second shots with 10 milliamperes at 60 KV. with two-second intervals between consecutive shots.

Tubes are usually held in stock for several days after testing, and they are finally given a short test and are then crated for shipment.

A STUDY OF GAS-CONTAINING ROENTGEN RAY TUBES AND A DESCRIPTION OF A NEW TUBE

By A. MUTSCHELLER

Research Physicist, Research Laboratory, Wappler Electric Company

NEW YORK

INTRODUCTION

THE unstable vacuum of the gas-containing *x*-ray tubes and the final failure of the usual regulators have always been troublesome features. After considering the various theories supposed to account for these difficulties, the tube here described was constructed in the hope of securing a more stabilized vacuum and of supplying a regulator which would give at once better control and longer life to the tubes.

Kaye [1] states: "Systematic work is needed to find the most suitable gas for an *x*-ray tube. Unless precautions to the contrary have been taken, the gas will probably consist largely of hydrogen and carbon dioxide liberated from the electrodes. Platinum and especially aluminum (and magnesium) emit large quantities of gas when used as cathodes. This point is also of importance in connection with the various methods of controlling the hardness of bulbs. The automatic devices introduce, chiefly, carbon dioxide and, in some cases, a little water vapor; the osmosis valves, hydrogen; the Bauer valve, air. So far as sputtering goes, hydrogen and carbon dioxide would appear to have advantages, though there is some diversity of opinion on this point. On the other hand, it may be remarked that a tube rendered unsteady by the hardening effect of hydrogen may often be caused to run smoothly by letting in a little air."

In view of the fact that very little experimental work has been done on this subject, and because of the inherent advantages arising from the ability to control and run continuously and uniformly the gas-containing roentgen ray tube with its valuable properties, the investigation, reported in the following article, was undertaken with the object of studying:

1. The nature of the equilibrium between the residual gases, the metals of the electrodes, and the glass walls of the gas-containing roentgen ray tubes used at present.
2. The nature of the process of seasoning through which greater constancy of vacuum is obtained when the electrodes are heated by the passage of current through the tube.
3. The behavior of different homogeneous gases in contact with the metals and the glass wall of the tube when these are heated to higher temperatures.
4. The nature of the action of the vacuum regulating systems commonly employed and the effects of their use upon the vacuum and the properties of the tube.
5. Experiments with a new gas and a new regulating substance; also a new type of regulator and the results obtained therewith.

THE ADSORPTION OF GASES BY SOLIDS; REPORT OF EXPERIMENTS

In an attempt to explain the process of adsorption between substances in different phases, particularly of solids and gases, F. Haber [2] expounded the theory of the structure of solids and crystals which is based on the experimental work of Laue and Bragg on *x*-ray spectra. He concluded that solids are bound together by the valence forces of the atoms which hold them in a regular arrangement or pattern. But since there is no evidence that atoms are differently arranged at the surface than in the interior, there must be free and unoccupied valences at the surface of the solid reaching

[1] Kaye, G. W. O. 1917. *X-Rays*, page 83.

[2] Haber. 1914. *Zeit. f. Elektroch.* 20, 521.

out into space, and these valences, which are distinctly chemical in nature, account for the phenomena called "adsorption" phenomena. Because of the existence of valence forces at the surface of a solid, finely divided substances like palladium and nickel due to their large surface are capable of adsorbing large volumes of gas. The adsorption combination, however, has the property of being generally less stable at higher than at lower temperatures, i.e., if an adsorption complex is heated it splits up or dissociates into its component parts.

As is rendered evident by the manner in which ordinary roentgen ray tubes act during operation, there are changes taking place in the relation between the metals and the gas during heating and cooling of the tube. The series of experiments described in the following were undertaken with the object of determining the relation of the metals to various gases both during the process of heating the system and during cooling for the purpose of discovering the gas which would be best suited as a residual gas for roentgen ray tubes.

In the following is given a short description of the apparatus employed, and the method of obtaining the results together with a tabulated report. The apparatus employed consists of a thin wall glass bulb

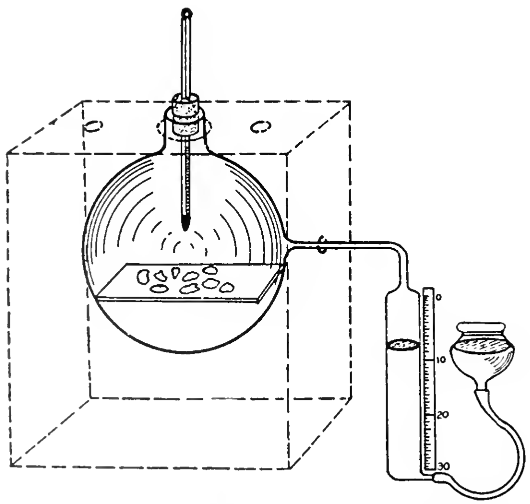


FIG. 1. APPARATUS EMPLOYED IN THE LABORATORY TO STUDY THE RELATION BETWEEN GASES AND METALS AT VARIOUS TEMPERATURES.

(capacity 407.40 c.c.) on which is sealed a narrow tube that is connected to a mercury manometer. At a distance of 45 degrees from this, is a larger opening, into which fits an asbestos stopper with a thermometer reaching some distance into the glass bulb. Into this glass bulb was placed a glass support upon which the metal pieces could be placed. This bulb was enclosed in an asbestos box so that only the two necks projected (Fig. 1).

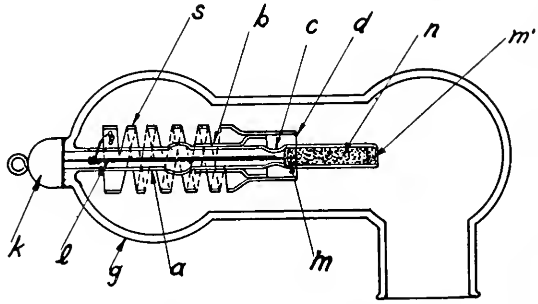


FIG. 2. THE NITROGEN VACUUM REGULATOR.

TABLE I

Experimental data showing the absorption of *oxygen*, by iron, copper, aluminum and bismuth at temperatures varying from room temperature to 350 degrees centigrade and decreasing again to room temperature.

Temperature Degrees Centigrade	*Gas level measured downward at atmospheric pressure in the manometer tube at room temperature (cms.)*				
	No Metal	*15 g. Fe*	*15 g. Cu*	*15 g. Al*	*15 g. Bi*
18	0	0	0	0	0
50	4.5	4.0	4.0	4.0	4.0
100	9.0	8.5	8.0	8.0	8.0
150	13.0	12.0	11.5	10.5	11.0
200	17.0	15.5	14.0	13.5	13.0
250	21.5	18.0	15.0	16.0	15.0
300	25.0	20.0	16.5	18.0	16.5*
350	29.0	21.5	19.5	20.2	17.2*
300	25.0	18.5	16.5	17.5	16.0*
250	21.0	15.0	14.5	14.0	14.0
200	17.0	10.0	10.0	10.5	12.0
150	13.0	3.0	3.0	7.0	9.5
100	8.5	—	—	3.5	6.0
50	4.0	—	—	—	3.0
18	0	—	—	—	0

* Bismuth in molten condition.

The manometer employed consisted of a glass tube 4 cm. wide with a small side tube attached at the lower end. To this was con-

nected a rubber tube terminating in a large diameter glass container for the mercury. Behind the tube was placed a metric scale from which the differences in the gas volumes could be accurately read. The upper end of this tube was sealed to the small outlet communicating with the glass bulb. Readings were taken on a metric scale after the mercury levels were adjusted to the same height by raising or lowering the glass container connected with the tube.

The apparatus was filled in the following

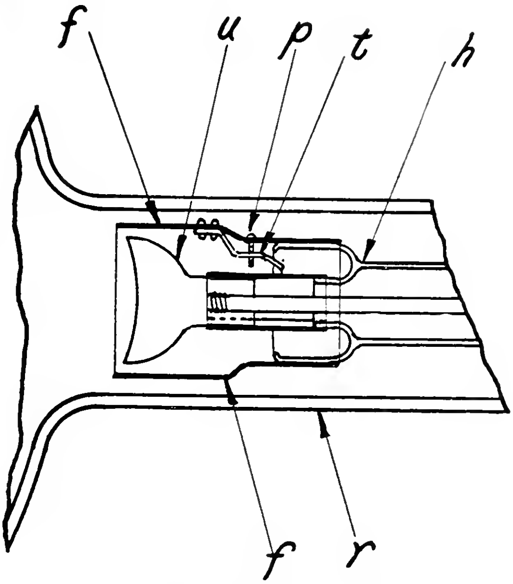


Fig. 3. Protective Shield for Cathode.

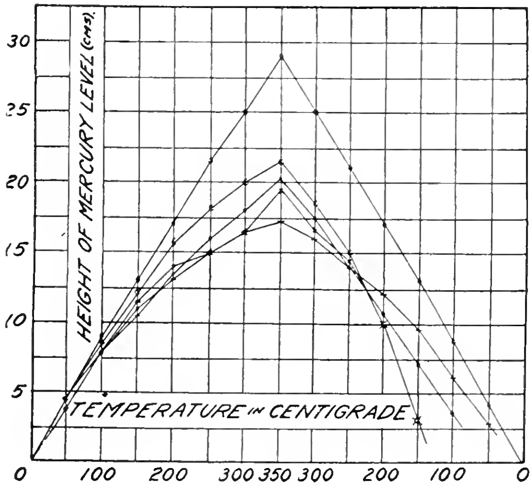


Fig. 4. Curve 1 Showing the Changes of Volume of Oxygen when at Various Temperatures.
o Oxygen without metal.
c Oxygen in contact with iron.
x Oxygen in contact with copper.
. Oxygen in contact with aluminum.
+ Oxygen in contact with bismuth.

TABLE 2

Experimental data showing the absorption of *hydrogen*, by iron, copper, aluminum and bismuth at temperatures varying from room temperature to 350 degrees centigrade and decreasing again to room temperature.

Temperature Degrees Centigrade	*Gas level measured downward at atmospheric pressure in the manometer tube at room temperature (cms.)* No Metal	15 g. Fe	15 g. Cu	15 g. Al	15 g. Bi
18	0	0	0	0	0
50	4.5	4.5	4.5	4.5	4.5
100	9.0	8.5	8.5	8.5	8.5
150	13.4	12.0	12.5	13.0	11.6
200	17.0	15.0	16.0	16.5	15.2
250	21.0	18.2	19.3	20.5	18.5
300	25.0	21.5	22.5	23.5	21.0*
350	29.3	24.0	25.0	25.5	22.0*
300	25.5	20.0	21.3	22.5	21.5*
250	21.5	15.5	16.5	18.5	20.0
200	17.5	11.0	11.5	14.5	18.0
150	13.5	6.5	6.5	10.5	15.0
100	9.0	2.0	0.0	6.0	12.5
50	4.8	—	—	1.0	10.2
18	0.0	—	—	—	9.0

* Bismuth in molten condition.

TABLE 3

Experimental data showing the absorption of *nitrogen*, by iron, copper, aluminum and bismuth at temperatures varying from room temperature to 350 degrees centigrade and decreasing again to room temperature.

Temperature Degrees Centigrade	*Gas level measured downward at atmospheric pressure in the manometer tube at room temperature (cms.)* No Metal	15 g. Fe	15 g. Cu	15 g. Al	15 g. Bi
18	0	0	0	0	0
50	4.5	4.5	4.7	4.5	4.5
100	8.8	8.5	9.5	8.5	9.0
150	13.0	13.0	14.0	12.5	13.5
200	17.5	17.5	18.5	17.0	18.0
250	22.0	21.5	23.0	22.00	22.0
300	26.0	25.5	28.0	25.5	25.5*
350	30.5	29.5	31.5	30.0	29.0*
300	26.0	25.5	27.5	26.0	25.5*
250	22.0	21.5	23.0	22.0	22.0
200	17.5	17.0	18.5	17.0	17.5
150	13.0	12.5	14.0	13.0	13.0
100	8.0	8.5	9.0	9.0	9.5
50	4.5	4.0	4.5	4.0	5.0
18	0	0	0	0	0

* Bismuth in molten condition.

manner: The gas generator delivering the purified and dried gas was connected to the lower opening of the measuring tube. For this purpose the mercury vessel was lowered until all the mercury had run out of the measuring tube; the rubber tube was detached and the entire vessel was turned upside down. A steady stream of gas was kept flowing until it could be assumed that all the air had been displaced. The vessel was then heated to bring the glass walls into equilibrium with the gas; the gas within the bulb was displaced by new gas and the process of heating was repeated. After having made certain that the residual gas was well in equilibrium with the glass walls, and being reasonably certain of the purity, the temperature curves given in Figs. 2, 3 and 4, the data of which are reported in Tables 1, 2 and 3, were obtained.

With this apparatus it was possible to reach the temperature of 350 degrees centigrade, and the experiments herein reported were performed between this and ordinary laboratory temperature of 18 degrees centigrade. The data obtained with the pure gases are in fair agreement with the values calculated from the gas laws. The slight decrease at higher temperatures is undoubtedly due to cooling where the gas comes in contact with the mercury of the manometer. After obtaining the normal temperature-volume curves for hydrogen, oxygen and nitrogen, the same curves were determined in exactly the same manner after successively placing 15 g. of one of the metals upon the glass support within the bulb. The curves obtained are plotted together with the normal temperature-volume curve for the three gases mentioned, and from the differences found the relation between the metal and the gas employed can be determined.

The metals selected for these experiments are copper, iron, aluminum, and bismuth. The samples were prepared in the following manner: The metal was disintegrated into fragments of about pea size with the object of creating large but nearly equal surfaces. They were then treated with dilute acid to remove all surface oxides and were washed quickly and dried in a desiccator. Before being placed in the apparatus they were placed in a smaller glass bulb connected to an ordinary water pump. The water pump was started and while this pump was maintaining a vacuum of about 1.6 cm. Hg., the metal was heated under the full blast of four Bunsen burners. After some time the pump was disconnected, the vessel closed and the metals allowed to cool. The metal pieces were placed as rapidly as possible upon the glass in the lower part of the experimental bulb. Without increasing the temperature of the bulb, the gas was allowed to flow through the vessel for a sufficient length of time to make sure that all foreign gases had been displaced. The apparatus was then closed by introducing the asbestos stopper with a thermometer, and connecting it to the manometer. The temperature was then slowly increased and an attempt was made to keep constant the temperature indicated by the thermometer in various steps so that an equilibrium reading was assured. At the steps given in the tables the temperature was kept constant for approximately 10 minutes. During the first three or four minutes, a gradual change in the volume could be observed, but during the remaining period for which the temperature was kept constant, no further change in the volume of the gas could be noted. That the condition of equilibrium existed was therefore rendered certain. After reaching a temperature of 350 degrees, cooling was brought about in steps so that every reading was again taken at full equilibrium, *i.e.*, with constant temperature and constant volume maintained for at least five or six minutes.

DISCUSSION

Plotting of the experimental data reveals interesting facts regarding the equilibrium between metals and gases. The curves show clearly, in the case of oxygen and hydrogen, that a considerable amount of gas is absorbed by the metals with the exception of bismuth. But in the case of nitrogen the quantity of gas absorbed is so small as to be negligible.

An interesting characteristic is shown by bismuth in that at high temperatures it shows a tendency to adsorb gases, whereas at low temperatures it shows a distinct tendency to release gases. This characteristic might lead to the suggestion that bismuth could be used in combination with the other metals, the characteristics of which are just the reverse, and would then give rise to a system maintaining a constant gas pressure at various temperatures. However, because of the very low melting point of bismuth (270 degrees centigrade) its melting and vaporization in a high vacuum could not be prevented. In spite of the apparent advantages of bismuth, therefore, its use as part of the electrodes of roentgen ray tubes is impossible.

The results of these experiments which are directly pertinent to the problem of constructing roentgen ray tubes can, therefore, be summarized as follows: The metals commonly employed in the construction of roentgen ray tubes, viz., iron, aluminum and copper, when heated to higher temperatures show the greatest chemical adsorptive affinity towards oxygen and hydrogen, and the least towards nitrogen. The assumption made at the start is, therefore, corroborated since nitrogen, because of its inertness as a chemical factor, shows the least tendency to combine with the electrode metals most commonly used, and, therefore, appears to be most suitable as a residual gas for roentgen ray tubes.

THE EQUILIBRIUM BETWEEN THE RESIDUAL GASES, THE METAL OF THE ELECTRODES, AND THE GLASS WALL.

The commonly employed gas-containing roentgen ray tube consists of a spherical glass bulb within which are placed the electrodes made of tungsten, copper and aluminum. These tubes are then evacuated while being heated in a furnace, in most cases, however, without taking the precaution to secure a homogeneous residuum, i.e., one consisting exclusively of one particular gas.[3] The vacuum, therefore, consists of attenuated air composed of approximately 20 per cent oxygen, 79 per cent nitrogen, 1 per cent carbon dioxide and noble gases. Water vapor, as a rule, is removed with a drying chamber containing P_2O_5 which is connected with the interior of the tube during the pumping.

Oxygen has great chemical affinity toward iron and copper and, if present in the tube, these metals combine with or release oxygen according to whether there is an excess or deficiency of this gas. When heated to higher temperature these compounds dissociate very readily, which fact accounts for the decrease in vacuum caused by the heating of the electrodes. Polyatomic gases such as carbon dioxide, water vapor, etc., when attenuated to an x-ray vacuum and subjected to bombarding the target of the tube when it is in operation, probably almost completely dissociate giving rise to a mixture of monatomic gases which, like oxygen, generally induce sputtering of the electrode metal, and then, by being adsorbed by the metal vapors, give rise to considerable variation in the gas pressure.

THE PROCESS OF SEASONING NEW TUBES

While it is not possible to follow experimentally the changes that take place within a tube during the process of seasoning, it is possible from known facts and given conditions to conclude rather definitely what processes are taking place. If tubes have been evacuated, then the presence of chemically active gases in these tubes indicates that all changes in vacuum are due to the release and resorption of chemically active gases when the temperature changes, and that during the process of seasoning there is formation of a more stable chemical union between the electrodes, or some sputtered metal, and the active gases. The final result is that the residuum ultimately must consist of the chemically most inert gases, i.e., those which show the least tendency to combine and interreact with the metals.

Assuming that oxygen and nitrogen con-

[3] Except in the case of the hydrogen tube.

stitute the bulk of the gas left in the tube, we can imagine the process of seasoning taking place in the following manner: A new tube coming from the glass blower, as a rule, is evacuated slightly more than is required. If current is passed through such a tube it will be found that the vacuum decreases slowly and this decrease is unquestionably due to the release of gas from the surface layers of the electrodes. If, after being heated to a considerable degree, the electrodes are allowed to cool, they readsorb gases, especially the more active oxygen; this, when the process is repeated several times, tends to penetrate deeply into the pores of the metal and enters into a more and more stable union with the metal.

The process of seasoning, in the given case, therefore, consists of the selective adsorption of the more active oxygen by the electrode metals, with the result that the more inert nitrogen finally is left to constitute the residual gas in the tube. Due to the inertness of this gas, there results from the disappearance of all other gases greater constancy in the degree of vacuum when the tube is heated, since there is no marked adsorption of nitrogen, as experiments show, nor chemical combination with the metals or the glass walls of the tube.

THE ACTION OF THE COMMONLY EMPLOYED VACUUM REGULATING SYSTEMS AND THEIR EFFECTS UPON THE PROPERTIES OF THE TUBE.

For the regulation of the vacuum of roentgen ray tubes a great variety of substances are employed. Such gases as hydrogen, air, moisture, carbon dioxide, etc., are introduced into the bulb with the aid of a heated tube of palladium to admit hydrogen, a small valve to admit a small volume of air into the bulb, or, by placing various substances in a side tube communicating with the body of the roentgen ray tube and heating them, the introduction of gases into the bulb is brought about. The substances commonly employed are charcoal, caustic alkalis, soda, lime, asbestos wool, etc. As a rule, these substances are heated by high tension current whereupon they liberate water vapor, carbon dioxide, hydrogen, etc. From the foregoing discussions, it is to be expected that the introduction of such gases brings the tube back to the initial condition of decreased stability of vacuum, since the adsorption of the chemically active gases has to be effected in each instance when the regulator is used. Again, there is the danger of overheating these substances by an excess of current causing over-reduction of the vacuum to such an extent that repumping of the tube may become necessary. Furthermore, after repeated use it may happen that the substance becomes exhausted, having yielded all its available gas. In such a case, it is necessary to open the tube, to change the regulating substance, and to re-exhaust it.

EXPERIMENTS

A NEW GAS.—The final design and method of evacuating a new type roentgen ray tube is based upon the reflections and experiments outlined in the preceding chapters. The new tube consists of the body of a roentgen ray tube constructed and designed according to approved principles.[4] Before sealing the electrodes into the bulb they are freed as much as possible from grease, oxides, dirt, etc. The tube is then filled with nitrogen gas (specific gravity .97) by displacing downward the air contained in it. The nitrogen gas is produced by a special chemical reaction which frees the gas from nitrous oxide, oxygen, hydrogen, or water vapor. When the bulb is thus filled, it is placed in a heating furnace and the temperature is increased gradually until the electrodes are a dull red. Under these conditions, the electrodes come into equilibrium with the nitrogen with which the bulb is filled in such a way that the oxygen and other gases originally occluded by the electrodes and the glass walls diffuse into the mass of the nitrogen. The pumps are then

[4] An investigation into the design of cathodes and protecting sleeves led the writer to adopt the design illustrated in Fig. 5. A cathode of ordinary design is located within a steel cylinder of such diameter that the distance between the glass wall and the cylinder

started, and the gases liberated, together with the excess nitrogen, are pumped off to a sufficient degree of vacuum. The tube is then sealed and allowed to cool.

After being detached from the pump the tubes show a rather dense yellowish green fluorescence, as distinguished from the bluish green transparent fluorescence generally seen in new gas tubes or hydrogen roentgen ray tubes. When running a tube

is larger than the distance between the cylinder and the cathode. The advantage of this arrangement is that the cathode rays emitted backwards and sideways by the cathode are caught in this cylinder and the energy accumulated on it discharges back to the cathode, i.e., the space between the glass wall and the cylinder must be large enough to prevent the dis-

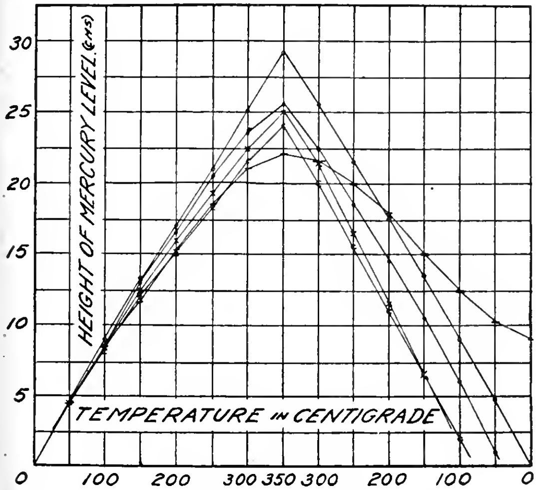


Fig. 5. Curve 2 Showing the Change of Volume of Hydrogen when at Various Temperatures.

o Hydrogen without metal.
c Hydrogen in contact with iron.
x Hydrogen in contact with copper.
. Hydrogen in contact with aluminum.
+ Hydrogen in contact with bismuth.

charge of the *potential* accumulated on this cylinder to the glass wall. It was found that under those conditions no great *potential* accumulates on the cylinder, probably due to the fact that between the impulses this cylinder has an opportunity to discharge over to the cathode. In order to prevent the cathode rays which come from the concave surface from falling on the glass wall and to produce better focusing upon the anticathode target, this cylinder is about 1/16 of an inch beyond the cathode. A small spark gap between the cylinder and the cathode, arranged within the glass holder of the latter, is found advantageous to prevent sparking at the border of the cathode and to prevent the introduction of aluminum vapors into the body of the bulb.

thus provided and equipped with an adequate regulating substance, a remarkable constancy in the degree of vacuum is discovered. By this procedure all those gases with which metals are capable of entering into chemical combination have been liberated and displaced by the inert nitrogen gas, and, after bringing the tube to the desired degree of vacuum, no further release or adsorption of this gas takes place owing to its inertness as a chemical factor.

A New Regulating Substance.—In order to preserve the advantages gained by producing a homogeneous residuum of inert gas within the tube, the homogeneity of this gas must be preserved. For this purpose the methods and substances hitherto employed for the regulation of the gas pressure of the tube are inadequate. Guided by the experience gained, the preparation of a substance was undertaken which should fulfill the following conditions:

1. The substance, when electric current passes through it, shall liberate pure nitrogen only, without the admixture of any other gases and without the production of metal vapors.

2. The substance must be capable of adsorbing all other gases (oxygen, hydrogen, oxides, etc.) which are chemically more active while adsorbing nitrogen only to a moderate degree.

3. The substance, when electric current is passed through it, must liberate nitrogen only, retaining tenaciously the other gases which are chemically more active.

4. The substance must possess a moderately good electrical conductivity.

5. The vapor pressure or dissociation pressure of the substance must be lower than the gas pressure in the tube.

The nitrides of certain metals, i.e., the chemical combination of a metal with nitrogen, were found to answer these conditions more or less satisfactorily. Thus the nitrides of thorium, aluminum, barium, etc., or a mixture of these, were found to liberate a large amount of gas by the passage of current through them. After considerable ex-

perimenting, a mixture was finally found which, when prepared according to a certain process, answered all the above requirements and proved to be an ideal substance for the regulation and control of the vacuum of tubes.

A New Type of Regulator.—A change in the design of the regulating chamber became necessary to preserve the conditions which the regulating substance must fulfill and to guard against accidental over-reducing of the vacuum. The pattern illustrated in Fig. 6 is the result of a number of experiments with different types of regulators. It consists of a glass cylinder, *a,* narrowed down at the point, *c*; through this narrow

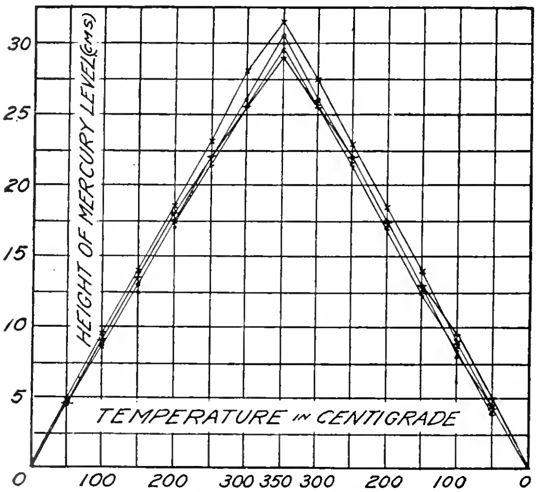


Fig. 6. Curve 3 Showing the Changes of Volume of Nitrogen when at Various Temperatures.

o Nitrogen without metal.
c Nitrogen in contact with iron.
x Nitrogen in contact with copper.
. Nitrogen in contact with aluminum.
+ Nitrogen in contact with bismuth.

part passes an aluminum rod, *l,* which extends a short distance beyond the plug of asbestos wool, *m,* into the regulating substance, *n,* above described. This substance is held in place by a second plug of asbestos wool, *m.* Over this glass cylinder is placed a cylinder of aluminum, *d,* covering about one-third of the regulating substance, and connected to a spiral of aluminum, which, together with the aluminum rod, is attached to the metal cap, *k.* These parts are placed within a glass container, *g,* which is shaped as shown in the drawing.

This arrangement offers the following advantages:

1. When high tension current is applied at the terminal, *k,* if the vacuum of the tube is high, the current will pass through the aluminum wire, *l,* into the regulating substance liberating pure nitrogen in proportion to the amount of current passing.

2. If, on the contrary, the vacuum of the tube is low, current applied to terminal cap, *k,* will not pass through the regulating substance, *n,* but will be switched off through spiral, *s,* to the cylinder, *d,* and will pass on through the vacuum to the positive electrode in the tube.

3. The design of the glass parts is such that the discharge of comparatively heavy currents into this regulator will not cause any local overheating of the glass parts which would result in breakage.

The objects stated under (1) and (2) are made possible by the fact that the low vacuum of the tube provides a path of less resistance for the current when emitted from a metal surface than does the point surrounded by the regulating substance. If, on the contrary, the vacuum is sufficiently high to offer a greater resistance to the current than the regulating substance, the liberation of nitrogen gas and a reduction of the vacuum is the result.

This device, therefore, if the resistance of the two paths of the current is properly balanced, guards against accidental over-reduction of the tube, for at the moment that a certain of degree of vacuum has been obtained by the current passing through the regulating substance, it immediately switches over to the metal cylinder; the latter then assumes a pink glow and no further discharge takes place through the regulating substance, consequently no further liberation of gas ensues.

The proportions of the new tube are such that the tube reduces slightly lower than the practical working vacuum, but no further reduction can be obtained, even with pro-

longed and heavy current passing through the regulator. If slight over-reduction is caused, allowing the tube to stand for about fifteen minutes, then passing a moderate amount of frequently interrupted current through, it will cause the vacuum to increase again to the normal working vacuum.

THE RESULTS OBTAINED.—The properties of the new tube are in marked contrast to those of the ordinary commercial gas-containing roentgen ray tube. A few experiments may illustrate the greater range of application developed in this tube.

One of the new tubes adjusted to 5 milliamperes and 6-inch back-up (64,000 volts) reduction as far as possible is 0.158, i.e., minutes. The anticathode was then red hot, but 5 milliamperes and the back-up of 6 inches were maintained. The same tube adjusted after cooling to a 4-inch back-up and 40 milliamperes could be used to make an exposure of 10 seconds, in steps of one seconl each, without any change in vacuum; after a lapse of 20 seconds another similar exposure of 10 seconds was made without causing the vacuum to decrease or increase. Such an exposure is more than sufficient to obtain a stereoscopic pair of plates of the heaviest parts of the body since there are 400 milliampere seconds at 65,000 volts available for each exposure.

After cooling, the tube was reduced as far as possible, and, in addition to this, a current of 30 milliamperes was passed through the regulator for 10 seconds. The passing of this extra current did not cause any further reduction; the tube, however, as it was adjusted by balancing the resistances for the current paths in the regulator, was slightly too low in vacuum for average work. It showed a back-up of 2½ inches when passing 40 milliamperes. But, after allowing it to stand for 5 minutes and occasionally passing a few flashes of current of about 20 milliamperes through it, the tube returned to its normal condition, passing 40 milliamperes at 4 inches back-up; in 15 minutes it was so high again, that it had to be reduced.

METHOD OF USING THE NEW TUBE

Since the regulating substance contains a very large amount of chemically combined nitrogen and since, during the intervals between exposures, the gas is adsorbed and released again when the tube is reduced, there is no danger that the regulating substance will become exhausted. For that reason, the tube is pumped to a rather high vacuum so that it can be reduced to any desired degree. Between exposures it always returns to high vacuum.

In case the tube has been over-reduced (the limit of lowest vacuum obtainable by reduction as far as possible is 0.158, *i.e.,* $\frac{\text{back-up}^2}{\text{milliamperes}}$,[5] the vacuum can be increased milliamperes[5]) the vacuum can be increased again either by allowing the tube to stand for a short time, then running the tube with low current, 3-6 milliamperes, or by passing from 20 to 25 milliamperes in very short flashes in rapid succession, i.e., about twenty or thirty flashes of approximately 1/10 of a second each. This flashing probably results in bringing the residual gas into contact with the regulating chemical. Since it is known that the highest gas pressure, when the tube is actuated, is directly behind the anticathode target, the tube should not be heated during this process, but should be run with short flashes for the purpose of concentrating the gas particles in the vicinity of the regulating substance. On the other hand, when normal exposures with about 40 milliamperes are made, the tube does not show this tendency to increase in vacuum because with heavier current there are more ions formed and consequently less accumulation of gas particles behind the anticathode target. When heavy current is passed through the tube, this fact is indicated by the absence of the small blue cloud which is generally shown behind the anticathode target when a moderate amount of current, *i.e.,* 10 or 15 milliamperes, is passed through the tube.

[5] MUTSCHELLER, A. Principles for the Use of Roentgen Ray Tubes. W. E. Co., 1917, p. 12.

The new tube, on account of the flexibility with which the vacuum can be adjusted, offers the great advantage that any desired penetration or volume of tube discharge can easily be obtained. The tube should be reduced and adjusted accurately to the desired degree of vacuum immediately before each exposure is made, because the regulator is sensitive to the action of current, i.e., is readily capable of yielding and readsorbing nitrogen. Due to its large content of gas and the reversible liberation and adsorption of gas, the regulator is practically inexhaustible.

SUMMARY

The principal advantages of this tube can be summed up as follows:

1. Constancy of operation is afforded for prolonged or heavy exposures at any desired degree of vacuum.

2. The tube can be adjusted to any desired degree of vacuum due to the fact that during the interval between exposures the tube returns to the initial condition of high vacuum.

3. The process of "seasoning" is eliminated; a new tube works under exactly the same conditions as an old well-seasoned tube.

4. The design of the tube and regulator are such as to protect the glass parts of the tube from local overheating and to prevent the production of metal vapors from the electrodes.

5. Protection is afforded against the possibility of over-reducing the vacuum by passing discharges through the regulator that are too heavy or too long.

6. In case the reduction has been carried beyond the point of normal vacuum, the tube returns to high vacuum in a short time, so that no inconvenience or further expenditure is brought about by having over-reduced tubes sent to the tube maker for re-exhausting.

THE AMERICAN JOURNAL OF ROENTGENOLOGY

PUBLISHED BY PAUL B. HOEBER, NEW YORK CITY

Issued Monthly. Subscription, $6.00 per year. Advertising rates submitted on application. Editorial office, 480 Park Av., New York. Office of publication, 67-69 East 59th St., New York.

TWENTY-FIRST ANNUAL MEETING

The Twenty-first Annual Meeting of The American Roentgen Ray Society will be held at Rochester, Minn., and Minneapolis, Minn., September 14, 15, 16 and 17, 1920; at Rochester on the 14th, at Minneapolis on the 15th, 16th and 17th.

Further details and advance information concerning the meeting will appear in these columns from month to month.

Minneapolis headquarters, Curtis Hotel.

DR. JOHN A. LEE

The death of Dr. John A. Lee at his home in Brooklyn, N. Y., on April 4, 1920, adds one more to the list of those pioneers in the use of the roentgen rays who have given up their lives as a result of injuries sustained before the dangers of the rays were recognized. Dr. Lee began this work in 1889, operating the first hospital equipment in Brooklyn. Like most of the early workers, he did much fluoroscopic work without protection, and by 1904 he had to abandon the work because of the injuries he had sustained, involving chiefly his left hand.

Having always had a leaning to surgery, he then devoted himself to this branch of medicine, in which he was highly successful. At the time of his death, he was attending surgeon to the St. Mary's and Kingston Avenue Hospitals, and consulting surgeon to several other institutions. He was a prominent member of the county and state medical societies, and was last December elected President of the Medical Society of the County of Kings.

Dr. Lee was born in New Britain, Connecticut, in 1873, and prepared for college at the New Britain High School. He was graduated from Yale College in 1895, and the Yale Medical School in 1897.

During the recent war he organized a naval hospital unit which served on the hospital ship *Comfort*. He was chief of the surgical service on this ship with the rank of Lieut. Commander, and shortly after going on the reserve list, was made Commander.

His medical history is unusual in that in 1908 he was operated on for axillary tumor, which proved to be carcinoma. In 1919, he was again compelled to submit to surgery, because of an axillary tumor, which proved to be sarcoma, and this was soon followed by metastases in the lungs.

JOHN G. WILLIAMS.

ANNUAL MEETING OF THE OMAHA ROENTGEN SOCIETY

The Annual Meeting of the Omaha Roentgen Society was held at the Hotel Fontenelle, March 27, 1920.

Clinics were held at the University of Nebraska and at St. Joseph's Hospital.

The following papers were read:

The Treatment of Cancer by the Roentgen Ray, Dr. A. P. Overgaard, Omaha.

Dr. W. N. Anderson of Omaha gave a few introductory remarks explaining the moving picture films which had been furnished by the United States Government demonstrating the principles of physical diagnosis as used in instructing the members of the medical corps during their army training.

Oral Infection in Its Relation to Systemic Diseases, Dr. Wm. W. Duke, Kansas City.

The Clinical Application of Peritoneoscopy, Dr. B. H. Orndorff, Chicago.

Dr. E. W. Rowe, of Lincoln, Nebraska, read a paper on Tuberculosis of the Kidney from the Roentgen Standpoint.

Dr. Harry A. Everett, of Lincoln, Nebraska, read a paper on the *X*-ray from a Surgical Aspect.

Dr. E. H. Skinner, of Kansas City, gave a talk on Management of Severe Malignancies of the Throat and Neck.

Dr. R. D. Carman, of Rochester, Minnesota, read a paper on Tuberculous Colitis.

Dr. J. B. Potts, of Omaha, Nebraska, read a paper on Maxillary Sinus Infection Secondary to Periapical Infection of the First Upper Molar and with Polypi.

During the luncheon, which was served at the Omaha Chamber of Commerce, Dr. Joseph Colt Bloodgood, of Baltimore, spoke of the Things that a Layman should know about the *X*-Ray.

A banquet was held in the evening, and Dr. Bloodgood gave an illustrated talk on The Roentgent Diagnosis of Bone Tumors. This talk was based upon pathological material secured at the Johns Hopkins Hospital during the past twenty-five years. It was logical, very comprehensive and entertaining. The doctor's research work in this line is unsurpassed and has opened up many new diagnostic points in the matter of bone disease. His reclassification of the names of bone tumors is admirable, greatly simplifying the nomenclature and making it much easier for the student to grasp the principles of the pathology.

The plate exhibit was well prepared and much interesting pathology was shown. The manufacturer's exhibit was as large as is usually found at a national medical meeting.

ANNOUNCEMENT

The Annual Meeting of the Western Electro-Therapeutic Association will be held in Kansas City, Mo., on May 27-28, 1920.

TRANSLATIONS & ABSTRACTS

DIEMER, F. E., and CRAMER, I. H. Roentgenological Determination of Pulmonary Tuberculosis. (*Am. J. M. Sc.*, Vol. CLVIII, No. 6, Dec., 1919.)

In plate interpretation, every shadow, configuration and position must be understood and carefully studied. The visibility of the broncho-vesicular tree must be appreciated for height, age, weight and occupation. The differentiation between peribronchial infiltration and thickening must be understood. The exact difference of degree of illumination and radiability is very important.

Abnormal configuration of the heart silhouette suggests valvular disease, which might account for abnormal lung shadows. Circumscribed areas resembling calcification are seen distributed throughout, particularly the lower quadrants, the result of dilated vessels in mitral disease.

Position and configuration of the diaphragm convey much information. The degree of parenchymal involvement is determined by the diaphragmatic position in deep inspiration. Previous pneumonias often leave pleurodiaphragmatic adhesions.

The condition of the hilus is extremely important. Infiltration, calcification or exaggeration results both from pulmonary infection and from abdominal infection, and the differentiation must be made from the general and minute lung picture.

The location of calcification areas throughout the lung fields is very suggestive. Diffused distribution suggests healed disseminated tuberculosis. A few areas in the lower quadrants designate the location of the primary tubercle, while those in the upper quadrants are more significant of quiescent, inactive or chronic active tuberculosis. The configuration and radiability of calcification areas suggest the activity of the process. Dense areas, undoubtedly lime salts, that are not discrete and where borders are not clear cut but blend gradually with the surrounding lung tissue, particularly if the center presents a delicate mottling (suggesting that the interstitial tissues remain intact), indicate that the process is active and the caseation area has not completely become calcified.

There are many pathological conditions which involve the lower quadrants but very few which involve the upper quadrants. If abnormal shadows are found in the upper quadrants the first thought is tuberculosis, although the pneumonias and various other conditions (which do not present the typical tubercular shadows) must be differentiated. If abnormal shadows are seen in the lower quadrants a non-tuberculous process is suspected.

CONCLUSIONS.—1. The definite determination of pulmonary tuberculosis by means of roentgen study alone in practically every stage is possible. The stage and the activity of the process are not as definitely established by roentgen study alone as by physical examination alone, but a combination of both is decidedly more reliable than either alone.

2. *The stage of an excavation is readily determined.*

3. *There are distinct roentgenological pathognomonic indications of pulmonary tuberculosis.*

4. *The exact involvement is more readily made out by roentgen study. Much assistance is furnished the clinician in regard to prognosis.*

The value of thorough roentgen study of the chest in tuberculosis varies slightly in different stages and forms of the disease.

1. In the incipient stage the roentgen study is of undoubted value, definite haziness, peribronchial infiltration and a marked degree of lessened illumination upon coughing or deep inspiration being determined on plate and screen. These roentgen indications appear as soon as does the clinical evidence.

In the cortical type the clinical findings are exaggerated while the roentgen evidence is not pronounced, but in the peribronchial and bronchopneumonic tuberculosis the findings are reversed. In these latter types there is apparently a hilus tuberculosis and the infection extends bronchogenetically, usually along the course of the vertebral, first intercostal and second intercostal bronchi.

2. After fibrous infiltration takes place the roentgen indications are almost pathognomonic, particularly for the disease, but also for activity to a slightly lesser degree. Even be-

fore mediastinal retraction appears the evidence of fibrosis is apparent because of the extensive bronchovesicular thickening, the delicate strand-like shadows and the further decrease in radiability. After organization of the fibrous process, with more or less retraction and the appearance of compensatory emphysema, the diagnosis is more readily reached; but activity is less easily determined. At this stage the process is very liable to become quiescent. The physical findings are then very indefinite indeed.

3. The caseation areas are not definitely made out, but after calcification takes place, whether with marked or little fibrosis, the diagnosis is definite for tuberculosis and the degree of activity is suspected.

4. (*a*) *The acute cavity does not present a definite, distinct capsule; its configuration is not oval or circumscribed but more likely to be irregular; the radiability of its center is the same or less than the surrounding parenchymal shadows; it does not illuminate upon the patient coughing and there is no distinct drainage sinus leading toward the hilus.*

(b) The subacute cavity begins to assume a definite circumscribed form; its capsule is readily seen, but is as yet not as definitely marked as in the chronic cavity; it usually contains a small quantity of fluid in its dependent portion, which indicates that drainage has not been perfected; above the fluid level the radiability is increased, indicating the presence of air. As yet the cavity does not illuminate upon coughing nor does the drainage sinus present as distinctly as later.

(c) The chronic cavity presents distinctly a fibrous capsule; it is oval or circular in shape, flat or spherical in configuration; it contains no fluid if the patient is examined late in the morning or in the afternoon; it illuminates brilliantly upon coughing and the thickened drainage sinus is readily made out.

(d) Healed cavities are not often seen; they present a very marked, thick capsule; contain no fluid; are very small in area and illuminate only slightly upon coughing. The drainage sinus is narrow, but its borders are very sharply outlined, indicating that no perisinus parenchymal involvement is present.

5. In the deep peribronchial type of tuberculosis, without parenchymal involvement, a distinct circumscribed peribronchial thickening will give way to an indication of peribronchial infiltration, and the bronchovesicular tree then presents a fuzzy rather than sharply delimited appearance. Extension of the process is then rapid, and there is an extreme lack of illumination on the plate, presenting a delicately mottled increase in density.

6. In massive hilus tuberculosis the roentgenologist is on a par with the clinician; its existence and activity can only be guessed. Before calcification no definite indications are seen, either by screen or plate; after lime salt deposit, visualization of the area is obtained and quiescence suspected if the calcification is uniform in radiability and sharply demarcated, and *vice versa.*

7. In disseminated tuberculosis the lung picture presents nothing definite unless healing takes place, when many small areas of calcification are seen distributed throughout both lung fields, the greater number in the lower quadrants.

8. Probably all types of pulmonary tuberculosis can be classed, strictly speaking, as a true bronchopneumonia during a certain stage, but the roentgenological presentation of an acute tuberculous bronchopneumonia, in which the parenchymal involvement is peribronchial, superimposed upon a chronic fibrous process, is distinctive and typical. True, it is impossible by any means to differentiate the acute pneumonic process, especially if the tubercle bacillus is found in the sputum with an abundance of streptococcus, particularly the hemolytic type. Streptococcus infection of the lung parenchyma often involves the upper quadrants, both unilateral and bilateral, and is extremely difficult to distinguish from a tuberculous infection.

An old quiescent lesion which becomes active following measles, pneumonia, etc., is inclined to involve either both lungs in their entirety, the opposite lung only, especially in its lower quadrant, or the lower quadrant of the same lung in which the lesion is located.

Calcification areas, wherever located in the lung, in the vast majority of cases indicate, that at some time there has been an active tuberculous process, but those of the lower quadrants are rather incidental, as healing usually takes place and the process stops at the bronchial glands. In the upper quadrants they indicate that the patient has a true, dangerous tuberculous infection which is either healed, quiescent or more or less active. If in

addition there are indications of fibrosis, with no emphysema and little or no mediastinal or chest-wall retraction, activity is indicated. If clear, irregular emphysematous areas are interspersed, with more or less retraction, and the calcification areas are clear-cut and uniformly dense, the process is probably quiescent, chronic-inactive or healed. Differentiation from lues, the fungi infections and the pneumonias can be made without difficulty, but only after observing many cases.

Excavations are unmistakable if studied by both plates and screen. Activity is at once established, the differentiation from non-tuberculous lung abcesses presenting no very great difficulty. The tuberculous cavities, except in a very small percentage, are found high in the upper quadrants and are often multiple or bilateral, while lung abscesses are practically always found in the body of a lobe and seldom multiple or bilateral. Pulmonary abscesses are either filled with broken-down, semi-solid tissue or with pus, the patients not living sufficient time for but few of them to establish drainage or air to collect above the fluid level. Lung abscesses invariably in a few days present a collection of air above the fluid level. The same is true of tuberculous cavities, but the surrounding lung shows unmistakable evidence of peribronchial thickening, fibrosis and other signs of tuberculosis, depending upon the stage of the process. A non-tuberculous cavity tends to heal if adequate drainage is established, and is seldom seen when empty, while the tuberculous cavity does not as often completely heal and is usually empty.

Other conditions to a lesser degree pathognomonic are as follows: Fibrosis, retraction of the trachea, mediastinal contents, heart and chest wall, a decided lack of illumination of one or both upper quadrants on deep inspiration or coughing before the screen, and a lessened radiability, either uniform or delicately mottled on the plate; abnormal presentation in the upper quadrants if there is a hanging "dropped" or very small heart silhouette; or if the diaphragm on the corresponding side is in partial expiratory position or its excursion is impaired on deep inspiration. Any abnormality found in the upper quadrants should prompt the roentgenologist to suggest the probability of tuberculosis unless definite indications of another process are certain.

Webster W. Belden.

Molyneaux, E. S. Radium in the Treatment of Tuberculous Adenitis. (*Brit. M. J.*, November 29, 1919.)

This article reports a series of from twenty to thirty cases of tuberculous adenitis treated with radium with marked success. Nodes at all stages of the disease were in the series and in all of them the swelling disappeared leaving no scar unless a sinus had been present at the beginning of the treatment. Ulceration did not occur in any case. Fifteen milligrams of radium bromide spread over an applicator one and one-fourth inches in diameter, screened by one millimeter of silver was strapped over the area to be treated for ten hours. Two applications a week were usually employed. After a week or ten days the swelling was seen to begin to grow smaller and at the end of a few weeks nothing but fibrous nodules were left to show the place of the old lesion. In some of the cases the cure has lasted for four or five years.

Espinola, Rafael. Radiotherapy in Surgical Tuberculosis of Children. (*Semana Méd.*, October 30, 1919.)

The author is convinced that radiotherapy, in the perfected technic of the present day, is the treatment of election in surgical tuberculosis, more especially in the larger cities where the benefits of fresh air, sunshine, and proper food are often not available. The rapidity of resolution of glandular masses is in direct relation to the dose of the rays. Cold abscesses, the pus of caseous suppurating adenitis, should be evacuated by simple incision followed by intensive radiation. The dose and length of session of the *x*-ray treatment can be adapted to the intensity of the bacillary infection; high virulence calling for large doses, low virulence for small doses. It is possible to give daily treatments for fifteen days without producing a dermatitis, providing the rays are filtered and of short wave length. There is no advantage in intensive radiation of cutaneous tuberculosis in the stage of reparation as this destroys the new cells which form the cicatrical tissue. It is advisable to employ, in conjunction, general hygiene, ample nourishment, heliotherapy, fresh air, and the proper climate to defend the system against the tubercle bac-

illus, and to prevent the formation of new foci. Surgery, in most cases of surgical tuberculosis in children, should be looked upon as a method of secondary importance; scientifically practiced, roentgenotherapy either alone or associated with other phases of treatment is quite capable of curing the so-called surgical affections.

DIMIER ET BERGONIE. Recherche du filaire de Médine par la radiographie (Guinea-worm Revealed by X-rays). (*Archiv. d'électr. méd.*, 1918, Vol. 26, 337.)

Usually animal parasites are so transparent to x-rays that their existence in the body is not revealed by these means: when calcified, however, they may be recognized. The authors found evidences of Guinea-worms in several wounded soldiers from Guinea and Senegal, in whom the existence of an abscess called for treatment. Apart from radiological examination the abscess might have been suspected to depend upon some military injury. The entozoa were always found in the usual situation, viz., leg or lower part of thigh, and the x-ray examination showed a tortuous coiled arrangement of the worm.

W. S. L.-B.

KEY UND AKERLUND. Fall von verkalktem Aneurysma in der Arteria renalis (Calcified Aneurysm of the Renal Artery). (*Fortschr. a. d. Geb. d. Röntgenstrahlen,* 1918, Vol. 25, 551.)

A somewhat laborious description of what appears to be a condition hitherto undescribed in radiological literature. The aneurysm was about the size of a hazelnut, its existence at the hilus of the kidney was recognized under the x-rays, an operation was done on the supposition that the case was one of renal stone, and the gush of arterial blood which took place and necessitated ligature of the artery and extirpation of the kidney afforded the first indication of the nature of the mass. Recognition of the condition as a source of possible error in diagnosis is desirable, but reduction of the paper to a quarter of its length would have been advantageous.

W. S. L.-B.

THE AMERICAN JOURNAL OF ROENTGENOLOGY

Editor, H. M. Imboden, M.D., New York

VOL. VII (NEW SERIES) JUNE, 1920 No. 6

THE DIAGNOSIS AND LOCALIZATION OF NON-OPAQUE FOREIGN BODIES IN THE BRONCHI*

By CHEVALIER JACKSON, M.D., F.A.C.S., WILLIAM H. SPENCER, M.D. AND WILLIS F. MANGES, M.D.

PHILADELPHIA, PA.

CLINICAL

THE importance of the diagnosis and localization of non-opaque foreign bodies in the bronchi is well illustrated by the following incident. A baby, twenty-one months old, was referred from the South by a skillful endoscopist who wrote that there was a history of choking on a peanut, but the internist and roentgenologist differed so widely and positively in their diagnoses that he did not feel justified in subjecting so ill a child to bronchoscopy on such uncertain evidence.

So much dependence has been placed on the roentgenographic localization of foreign bodies that when this aid becomes uncertain, because of the failure of the object to show in the ray, the whole scheme of things seems disarranged. It has been our fortunate opportunity to have been able to observe and record the physical signs, in hundreds of cases, of foreign bodies in the lower air passages and to compare the physical findings with those of the roentgenographer, both being checked by the actual location of the foreign body observed at bronchoscopic removal. This routine examination (even though the foreign body was known to be of a nature which would readily show in the x-ray plate) has enabled us to localize by physical signs the non-opaque bronchial foreign bodies with a considerable degree of accuracy. Most of the non-opaque bronchial foreign bodies are of organic nature, such as nut kernels, coffee berries, maize, beans, etc. Composition buttons, celluloid, wood, small bones, teeth, and other similar objects we have met with, and often they have not made distinct shadows on the plate.

Of the organic foreign bodies in the bronchi the peanut is the most frequent. As before pointed out [1] there seems to be some inherent irritating quality in nut kernels which causes a diffuse, edematous, purulent inflammation throughout the lower air passages of young children from the larynx to the finer bronchi. The inflammation is, however, most intense at the point of lodgment of the kernel, going on to ulceration and abscess formation if the foreign body is not removed. To this peculiar form of bronchial

[1] JACKSON, CHEVALIER. Observations on the Pathology of Foreign Bodies in the Air and Food Passages. Muetter Lecture, Dec., 1917. *Surg. Gynec. & Obst.*, March, 1919, p. 201.

* Read before the Eastern Section of THE AMERICAN ROENTGEN RAY SOCIETY, Atlantic City, N. J., Jan. 31, 1920.

inflammation the term "Arachidic Bronchitis" has been given.[2]

The reaction from other organic substances not opaque to the roentgen rays is much less severe and more delayed than in those of the arachidic group, and is usually limited to the point of lodgment and subjacent structures only. Much depends, however, on the shape of the foreign body and its lodgment; for if it completely occludes a bronchus, preventing aëration and drainage of the passages below, reaction will be prompt and intense. A portion of a red rubber eraser, aspirated into the right bronchus during an epileptiform convulsion in which the eraser was inserted between the teeth to prevent injury to the tongue, caused death in a man of thirty-six years from gangrene and multiple abscesses of the lung. The eraser showed in good plates, though it had been reported negative a number of times on inferior plates.

It is of the utmost importance to determine the presence of non-opaque foreign bodies—especially nut kernels—because they so quickly set up a fatal degree of pathology, in marked contrast to the often long symptomless sojourn of metallic foreign bodies. The severity of the reaction is in inverse ratio to the age of the child, children under two years of age seeming to suffer most. As the ages of four and five are reached the symptoms are much attenuated and the reaction may be localized to the bronchus invaded. It is probable that the increased size of the air passages and greater bechic power in the older children is a factor in the milder symptoms. Instead of working as separate and sometimes even antagonistic units the roentgenographer and examiner of the chest should consult together and endeavor to correlate their various findings. In order to do his best work the roentgenographer should have the salient points of the history.

Our first question becomes—Is there a foreign body present in the lower air passages? In adults the definite history of the inhalation of the foreign body can usually be obtained, although there are numerous cases in which the time and occurrence of aspiration of a foreign body is unknown, it possibly happening in childhood or perhaps during narcosis, as in the extraction of teeth. A presumptive diagnosis of foreign body in children may be made when the parents tell us that the child had an object in the mouth and suddenly choked, after which there developed wheezing respiration, paroxysmal coughing, dyspnea and fever.

The value of wheezing respiration as a diagnostic sign of foreign body in the lower air passages was first noted by Chevalier Jackson.[3] This wheezing resembles, but has a dryer quality than, that heard in asthma, and is best elicited by placing the ear of the observer in front of the open mouth of the patient and requesting a complete respiration. The "asthmatoid wheeze" is heard best when the air passages are coughed free from secretion, for its mechanism of production is the passage of air through the narrowing of the bronchial lumen caused by the presence of the foreign body. When a bronchus is completely occluded the "asthmatoid wheeze" is absent. The value of the wheeze as a diagnostic sign to the roentgenologist is evidenced by a case in which Dr. George C. Johnston reported to Dr. Jackson: "There is no foreign body on the plate but there is one in the patient."

Having made a tentative diagnosis of bronchial foreign body by the history, symptoms, and aid of the wheeze, our next question is, What is its location? Physical examination of the chest usually shows the unobstructed side to be somewhat fuller. Lessened expansion on the affected side is always noted. It may be that the intercostal spaces on the obstructed side will be retracted during inspiration. In the fully developed arachidic cases intense rhoncal fremitus will be felt on the free side.

Percussion on the obstructed side reveals,

[2] Jackson and Spencer. Arachidic Bronchitis. *J. Am. M. Assn.*, Vol. 73, p. 672, 1919.

[3] A New Diagnostic Sign of Foreign Body in Trachea and Bronchi, the "Asthmatoid Wheeze." *Am. J. M. Sc.*, Vol. CLVI, No. 5, p. 625, Nov., 1918.

in most of these cases, a peculiar impaired resonance which has associated with it a drum-like quality, and which we term "muffled tympany." It corresponds to the note of a drum which has its air vent plugged. We have explained this phenomenon by assuming that during inspiration a little air is allowed to pass the foreign body with the widening of the lumen of the bronchus known to occur during this phase of the respiratory cycle. With the narrowing of the lumen of the bronchus during expiration the air is prevented from escaping, so that there is maintained on the affected side air under pressure during the early stages of the condition. In later stages marked dullness, increasing to flatness as one percusses toward the base, is made out below the foreign body. This is due to the accumulation of secretions in the air passages below the obstruction and has been aptly termed by Dr. George C. Johnston "drowned lung." Still later, when destruction of the tissue occurs and lung abscess forms, the involved area will be denoted by its dull or flat percussion note.

The breath sounds are of greatly diminished intensity on the affected side in the early stages, and over an area of drowned lung they are usually absent. On the unobstructed side harsh breathing is heard, which, in the arachidic cases, is accompanied by very loud, snoring, snapping and bubbling bronchial râles. The vibration of these râles is transmitted with much lessened intensity to the obstructed side. In some cases in which the foreign body fails completely to occlude the bronchial lumen, the râles may be most intense over its site of lodgment. Vocal resonance is often, curiously, but little altered.

By careful study of the physical signs it can be determined what lobes of the lung are being deprived of air and drainage, and from this the almost exact location of the foreign body can be deduced. The patient is now in every case referred to the roentgenographer for verification of our findings and for the additional invaluable information which he alone can give.

ROENTGENOGRAPHIC

Dr. Willis F. Manges

Up to the present, roentgenological procedures have been of comparatively little value in the early diagnosis and localization of organic non-opaque foreign bodies in the lower air passages. Indeed, in some instances where the history was clear and the physical signs abundant, roentgenologists have erred as to the side which contained the foreign body. In other instances the opinion has been negative and, therefore, perhaps, dangerous. Only in the comparatively late stages when localized consolidation, abscess formation, or "drowned lung" appears, have we been able to express any valuable opinion as to the location of the lesion: and even then, in the absence of definite history, we have not been certain as to the diagnosis of foreign body. When these changes occur the patient has already reached a very serious stage in the course of the disease. The importance then of finding early positive roentgen ray signs must be apparent.

Our chief difficulty has been that we have not had the proper conception of the pathology present early in these cases, and particularly in the arachidic cases. We have been assuming that localized pneumonia, abscess, or retained secretions would show as areas of increased density in the very early stages, or that if a bronchus was plugged by a foreign body, then the foreign body should act as a ball valve letting air out but not permitting it to enter, thereby producing partial atelectasis distal to the foreign body, which of course should increase the density of the shadows.

The facts appear to be exactly the reverse of our former assumptions. The three charactertistic roentgenographic signs we would show you and describe in support of this statement are: 1. Increased transparency over the entire affected side. 2. Depression of the diaphragm on the affected side. 3. Displacement of the heart and mediastinal structures away from the affected side—in short, an acute, obstructive emphysema. And

we may perhaps add another—Increased density in the lung shadows on the opposite side due to retained secretions.

The discovery of these signs was made after Dr. Spencer had pointed out to me in one of this series of cases that the physical signs were of such a character as to make the diagnosis of foreign body almost a certainty. After having him demonstrate these signs to me I was convinced that he must be right both as to the presence and location of the foreign body. With this in mind we re-examined the plates together and noted the changes above described. Dr. Jackson then confirmed these findings by bronchoscopic removal of the foreign body.

I then reviewed the plates of other recent cases and found (1) that these signs were common to all of the arachidic cases; (2) that they all corresponded to the bronchoscopic findings; (3) that for the most part these signs disappeared shortly after removal of the foreign body.

It should be emphasized that the inflammation in the bronchi at the site of the foreign body is an essential factor in the production of this acute obstructive emphysema, and that it may be present in other than arachidic cases providing the foreign body causes sufficient inflammation. These signs were present in one of Dr. Jackson's cases where the foreign body was a piece of button, the shadow of which I did not recognize until after I had seen the piece of button in Dr. Jackson's hand, but then did recognize immediately. Before removal I had looked upon this as the shadow of an enlarged gland.

You will have been convinced, no doubt by the remarks of Drs. Jackson and Spencer that the diagnosis may be made from the history, clinical findings and physical signs when properly interpreted. Indeed, Dr. Jackson's results prove this. But I would remind you that the history is not always clear, and the clinical phenomena as well as the physical signs are not easily interpreted by those who have not made a special study of this type of lesion. The disease is neither endemic nor epidemic; but it is entirely probable that many children have died from arachidic bronchitis without the diagnosis ever having been made. On the other hand the roentgenographic signs that we have mentioned present no difficulty of interpretation now that we have discovered them. They are characteristic of foreign body plus inflammation sufficient to block a main bronchus, so far as we know. They become all the more important for the reason that the roentgenologist is so frequently called upon in emergencies.

The cases which we shall illustrate were all young children. We are not prepared to say that these signs would be present in older children or adults, because of the larger caliber of the bronchi.

There is nothing unusual in the roentgenographic technic. In fact, a plate considerably blurred by motion—an under-exposure or an over-exposure—will usually show the signs satisfactorily. The exposure should be central and through the medain line antero-posteriorly in order that one may depend upon the plate to show the position of the heart and diaphragm. We believe it is wise not to use undue force to restrain the motions of the child entirely, for the reason that breathing is already very difficult and rapid, and theoretically, it might be possible in a struggle to have the foreign body become dislodged and enter the opposite bronchus. Such an accident of course would certainly be exceedingly dangerous unless the bronchoscopist was immediately at hand and prepared to do a quick removal. Anesthetics or even sedative drugs are definitely contraindicated as an aid in making the roentgenographic examination.

CASE REPORTS

Case I. Fbdy. 725. F. A., aged twenty-one months. History of having been found choking with its mouth full of peanuts. Wheezing respiration, cough, periods of intense dyspnea and cyanosis, and fever developed. By physical examination the physician was of the opinion that there was a right-sided

bronchial obstruction. The roentgenologist, however, reported: "The roentgen examination of the chest shows an abnormal appearance of the left lung and particularly the upper portion. Two films were made, both of which gave sharp, clean-cut shadows, and show the right lung to be abnormally expanded, indicating that it is doing the work. I should be inclined to believe, considering

FIG. 1. CASE I. F. A. PEANUT KERNEL IN RIGHT MAIN BRONCHUS. Nine days after accident. The three characteristic signs of foreign body plus bronchitis are clearly shown. In addition localized increased density near right border of the heart indicates beginning abscess formation.

the history, that you were dealing with a foreign body in the main bronchus on the left side." (Fig. 1.) Because of these conflicting statements the consulted endoscopist referred the case to Dr. Jackson.

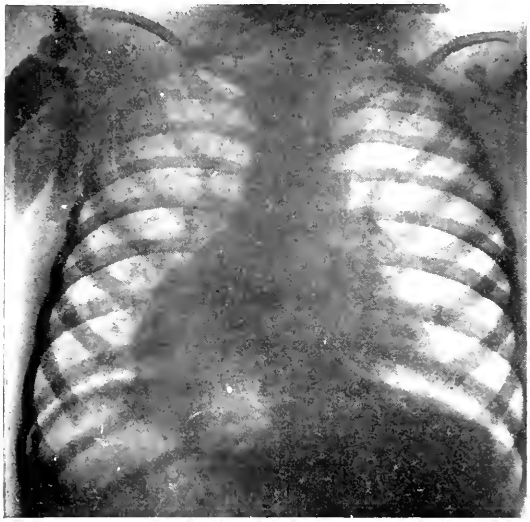
On arrival in Philadelphia, twelve days after the accident, the physical signs elicited by Dr. Spencer showed an obstruction of the right main bronchus. The peculiar muffled tympanitic percussion note and distant breath sounds were present on the right side, while the left side showed harsh breathing.

The happenings at operation were most interesting. When the bronchoscope had been inserted in the trachea a swab was introduced and withdrew a moderate amount of grayish pus, after which the patient coughed and become intensely dyspneic and cyanotic. After a few gasps for air, even though the bronchoscope was freed from secretion by sponge pumping, the cyanosis and dyspnea did not lessen; oxygen blown through the bronchoscope did not alter the condition, and the patient ceased breathing. Artificial respiration and bronchoscopic insufflation of oxygen were rewarded after three minutes by a return of the respiratory movements, although the cyanosis did not entirely disappear. The right bronchus was now rid of a large amount of bloody pus and its walls were found ulcerated. Small crumbs of peanut kernel were seen and removed from the right bronchus. The patient again became extremely cyanotic and it was quickly decided that there was obstruction of the left bronchus, for the right bronchus was free for respiration although the function of the right lung was seriously impaired by inflammatory reaction. The left bronchus was now searched and a large portion of peanut kernel found lying at the level of the upper lobe bronchus, after the removal of which the dyspnea and cyanosis disappeared in a few moments. The patient left the table in good condition.

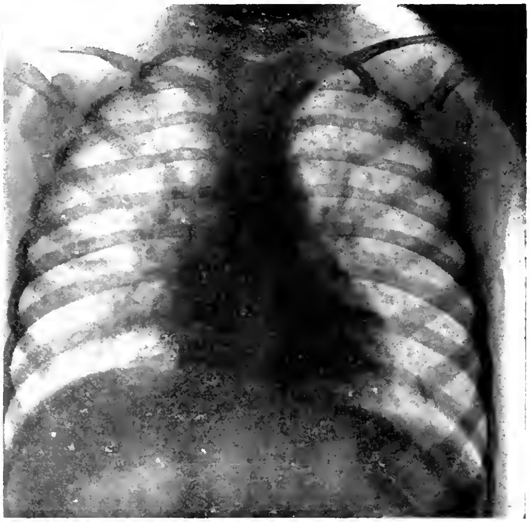
The above events are explained by the lodgment of the peanut kernel in the right main bronchus, where it lay at the time of the insertion of the bronschoscope, and from which it was dislodged by the first sponging, and coughing incident thereto. It was then aspirated into the left main bronchus. The left lung, which had been the functionating respiratory organ (the right lung being practically out of commission by inflammatory reaction), was suddenly choked off by the entrance of the peanut kernel into the left main bronchus. Had the peanut kernel not been promptly removed, death from asphyxia would have resulted. Tracheotomy became necessary later to facilitate the removal of the exceedingly thick secretion. (Figs. 2a and 2b.)

CASE II. Fbdy. 696. Aged two years. While seated in a rocking chair eating pea-

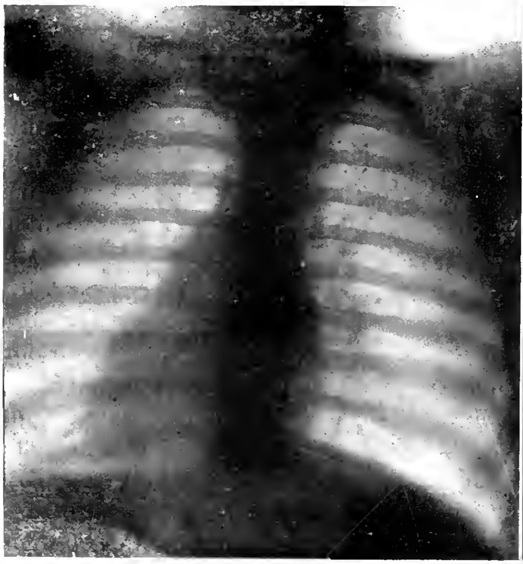
nut candy, too vigorous action caused the chair to fall over backward, which resulted in the aspiration of a portion of a peanut kernel. There was marked dyspnea and some cyanosis. Fever and paroxysms of coughing with marked toxemia later developed. Chest examination showed limited expansion on the right side, the percussion note showed



36163 F. A. Before Removal 7-24-19.
Fig. 2a. Case I. Peanut Kernel in Right Main Bronchus. Twelve days after accident. The three characteristic signs still present but less marked. Abscess formation more definite.



36178 F. A. After Removal 7-26-19.
Fig. 2b. Case I. Two Days Later after Removal of Peanut. Right diaphragm in practically normal position, right and left lungs show equal density. Abscess density has largely disappeared.



F. S. Before Removal 3-10-19.
Fig. 3a. Case II. Peanut in Right Main Bronchus. Three days after accident. Three characteristic signs are present but not to great extent, but clearly seen when compared with Fig. 3b, taken 6 days after removal. Tracheotomy tube in position.

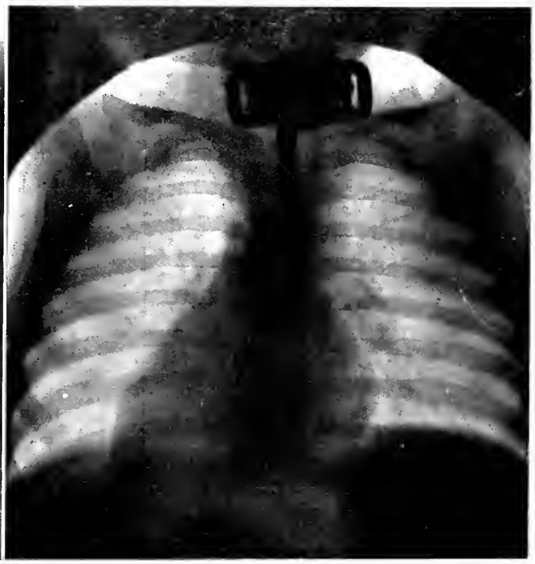
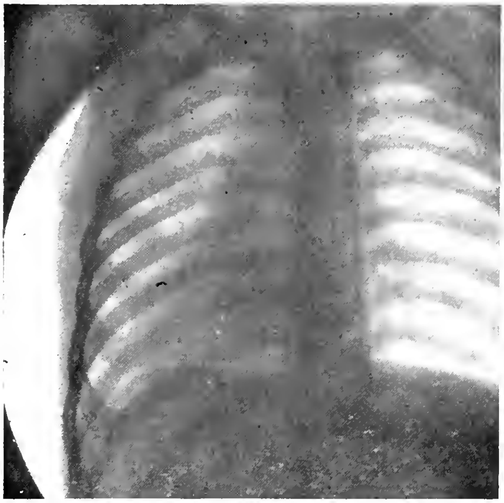


Fig. 3b. F. S. After Removal. 3-31-19.

the usual muffled tympany, and breath sounds were diminished but tubular in quality on the right side. The diagnosis from physical signs was obstruction of the right

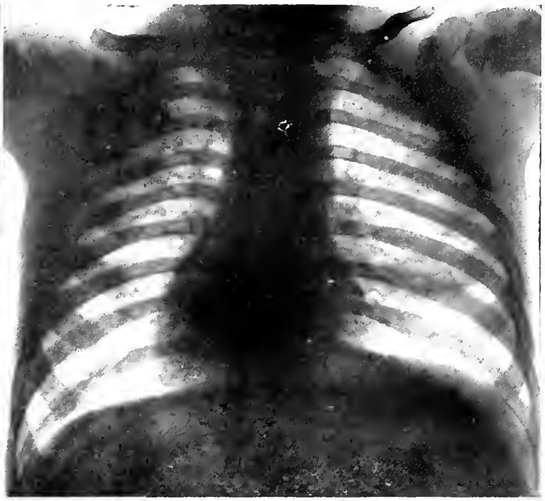
main bronchus, from which a peanut was removed. (Figs. 3a and 3b.)

CASE III. Fbdy. 743. Aged two years. Four days before admission patient had choked on a chestnut kernel, after which cough, dyspnea, fever, wheezing respiration and choking attacks occurred. At the time of physical examination the signs pointed to obstruction of the left bronchus. At bronchoscopy the left bronchus was found to be intensely inflamed with its mucosa swollen and covered with tightly adherent patches of exudate, but no foreign body was visible. On



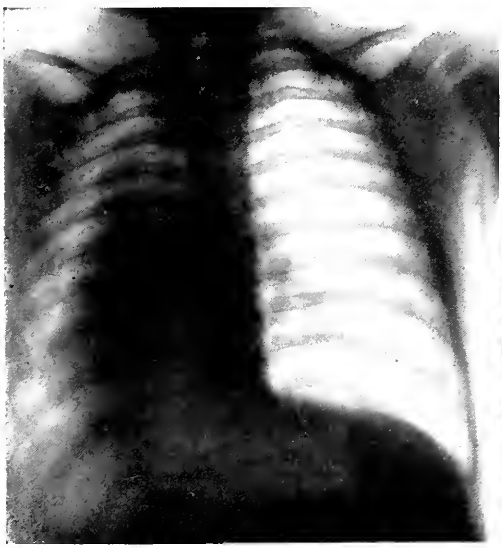
J. F. BEFORE REMOVAL. 10-7-19.

FIG. 4a. CASE III. FOUR DAYS AFTER ASPIRATION, CHESTNUT KERNEL IN RIGHT MAIN BRONCHUS. The three characteristic signs striking in appearance.



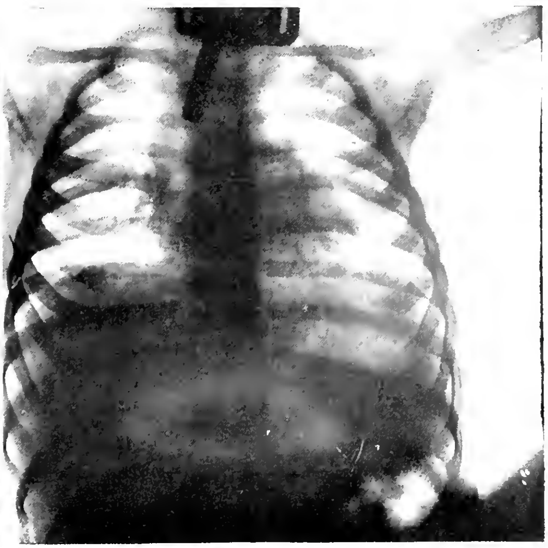
37389 J. F. AFTER REMOVAL. 10-9-19.

FIG. 4b. CASE III. SOON AFTER REMOVAL. Complete disappearance of the three signs of acute obstructive emphysema. (The difference in size of illustrations is due to variation in tube-plate distance.)



E. L. BEFORE REMOVAL 8-1-19.

FIG. 5a. CASE IV. PEANUT IN RIGHT BRONCHUS. Nine days after accident. The three characteristic signs quite marked.

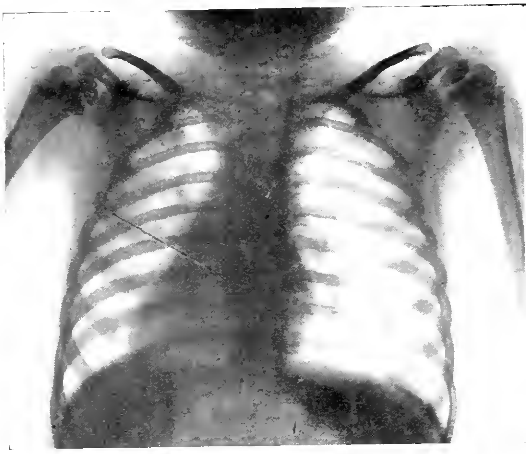


E. L. AFTER REMOVAL 8-12-19.

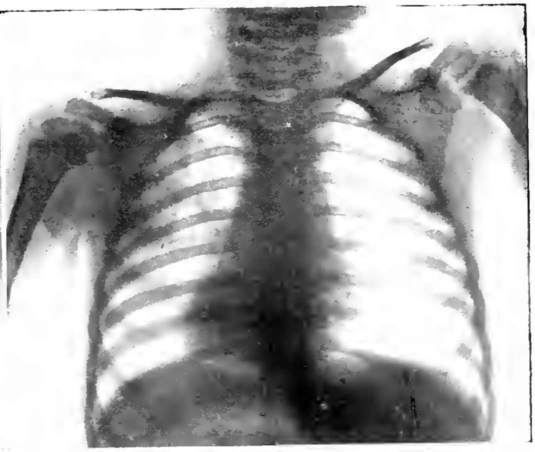
FIG. 5b. CASE IV. DISAPPEARANCE OF THESE SIGNS, ELEVEN DAYS AFTER BRONCHOSCOPIC REMOVAL. Tracheotomy tube in position.

searching the right bronchus a portion of chestnut kernel was found in the stem bronchus just below the upper lobe bronchus, tightly impacted. The right bronchus was inflamed but not nearly so much so as the left and no exudate or erosion was visible. It is quite evident that the foreign body was at first located in the left bronchus but was coughed up and re-aspirated into the right. (Figs. 4a and 4b.)

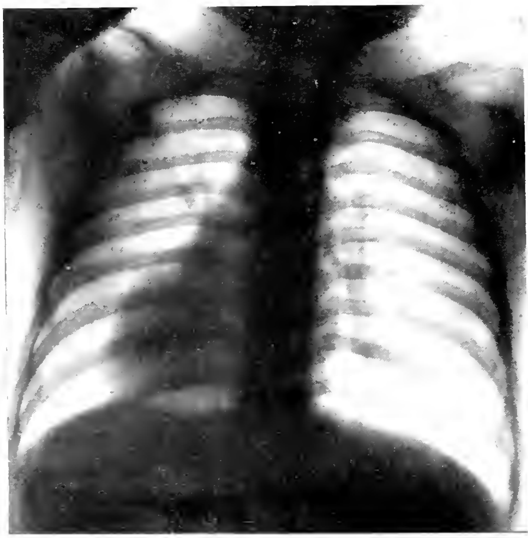
Case IV. Fbdy. 727. Aged one year. History of choking on a peanut kernel nine days before admission. Had wheezing respiration, fever and paroxysms of coughing attended with dyspnea and cyanosis. Physical examination showed obstruction of the right lower lobe bronchus. Portions of peanut kernel were removed from the right bronchus just below the orifice of the upper lobe bronchus. (Figs. 5a and 5b.)



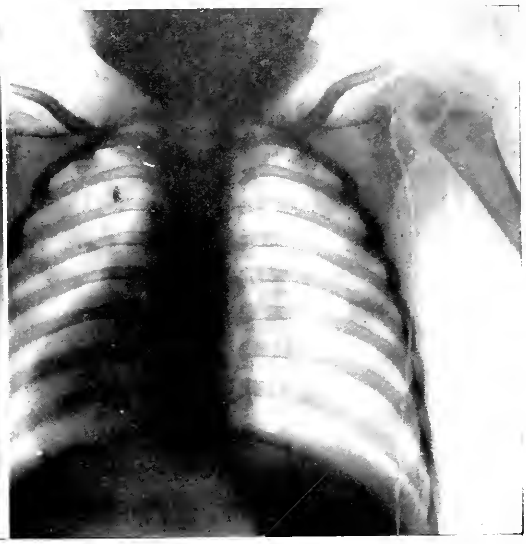
37759 Before Removal H. L. 10-29-19.
Fig. 6a. Case V. Peanut Kernel in Right Stem Bronchus. The three characteristic signs present but not extensively.



37829 After Removal H. L. 11-3-19.
Fig. 6b. Case V. Partial Disappearance of Signs Immediately after Bronchoscopic Removal.



38172 Before Removal J. S. 11-24-19.
Fig. 7a. Case VI. The three characteristic signs only slightly shown. Note shadow of piece of button right main bronchus not recognized as foreign body before operation.



J. S. After Removal 11-16-19.
Fig. 7b. Case VI. Note change in right diaphragm immediately after bronchoscopic removal.

Case V. Fbdy. 750. Aged two and one-half years. While eating salted peanuts child had a choking attack which was followed by wheezing respiration. Physical examination indicated obstruction to the right lower lobe bronchus with inflammatory processes involving the right upper lobe also. A portion of peanut kernel was removed from the right stem bronchus below the orifice of the upper lobe bronchus. (Figs. 6a and 6b.)

Case VI. Fbdy. 755. Aged fourteen months. Eleven weeks before admission parents stated that the child while playing on the floor suddenly choked and became cyanotic. Immediately after there developed wheezing respiration which persisted until the time of examination. No other symptoms were noted until the week before admission, when violent coughing developed and evening rises of temperature occurred. By physical examination it was determined that there existed a partial obstruction of the right main bronchus. A portion of button was removed from the right main bronchus at the level of the orifice of the right upper lobe bronchus. (Figs. 7a and 7b.)

CONCLUSIONS.

1. In the early stages of the reaction to foreign body in the bronchus there often occurs an over-distention of the lung on the side of the obstruction, the enlargement of the bronchial lumen during inspiration allowing the passage of a small amount of air, which the diminution of the bronchial lumen during expiration prevents from escaping. Thus a moderate distention of the affected side is obtained—an acute obstructive emphysema.

2. The three characteristic roentgenographic signs of this condition are:
    1. Increased transparency of the affected side.
    2. Depression of the diaphragm on the affected side.
    3. Displacement of the heart and mediastinal structures away from the affected side.

3. This unusual clearness of the obstructed side and the comparative clouding of the free side has led many observers to localize erroneously a non-opaque foreign body.

4. With the development of drowned lung or lung abscess, distinct shadows of the pathology allow the definite localization of the non-opaque foreign body; but to wait for this development may be of serious import, if not fatal to the patient.

5. The possibility of a shifting of the foreign body must always be kept in mind.

6. The roentgenologist should be in possession of the salient points of the history, and should interpret his findings in the question of non-opaque bronchial foreign bodies only after consultation with the examiner of the chest. In this way much confusion may be avoided and many new facts may be learned.

SECONDARY HYPERTROPHIC OSTEO-ARTHROPATHY WITH METASTATIC SARCOMA OF THE LUNG*

By LLOYD BRYAN, M.D.

Instructor of Roentgenology, University of California

SAN FRANCISCO, CALIF.

FIVE cases of secondary hypertrophic osteo-arthropathy associated with sarcoma of the lung have been reported; the

FIG. 1. RIGHT ARM SHOWING SOFT TISSUE TUMOR.

first by Saundby in 1889 as a case of acromegaly, but the postmortem findings are typical of hypertrophic osteo-arthropathy. Hall, Hasbrouck, Alexander and Cagnetto have each reported one case. The description of the latter case is more typical of osteitis deformans; however, differentiation between the latter and a late case of hypertrophic osteo-arthropathy may be difficult.

While it was not possible to obtain a postmortem examination, the roentgenograms of the following case are so typical that I wish to report it as a probable case of secondary hypertrophic osteo-arthropathy following metastatic sarcoma of the lung.

J. R., age twenty-nine, married; laundry worker; no family history of tuberculosis or malignancy; wife healthy; two healthy children; one miscarriage. No history of urethritis or lues; Wassermann was negative. Fifteen years ago patient was run over by a

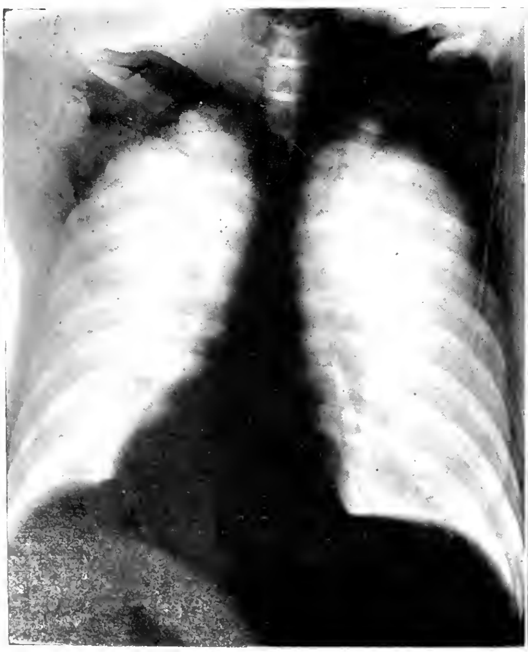


FIG. 2. CHEST ROENTGENOGRAM AT THE TIME OF THE SHOULDER AMPUTATION, MAY 9, 1916.

FIG. 3. CHEST IN SEPTEMBER, 1917—16 MONTHS AFTER OPERATION—Showing fluid and metastatic Malignancy.

* Read before the PACIFIC COAST ROENTGEN RAY SOCIETY, December, 1917.

wagon and had the middle third of the right arm badly cut and bruised. The wound healed readily, leaving considerable scar tissue. Five years after the accident, a rapidly growing mass appeared in the scar tissue and it was excised, but recurred within a year and was again removed. A year later, excision was again attempted and still later, a fourth excision was done.

At the time of entrance to the San Francisco Hospital, the arm was markedly enlarged and showed a large nodular tumor mass.


Fig. 4.


Fig. 5.


Fig. 6.


Fig. 7.


Fig. 8.


Fig. 9.

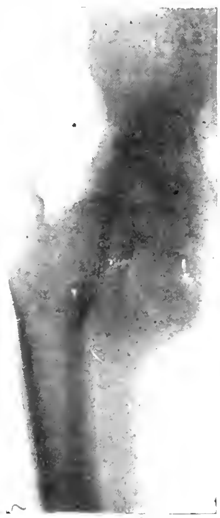


Fig. 10.

There was no apparent bony involvement (Fig. 1). There was no evidence of glandular involvement and no clinical or roentgen evidence of pulmonary involvement (Fig. 2). On May 9, 1916, Dr. Emmett Rixford did a thoraco-scapular amputation, from which the patient made an uneventful recovery. Dr. W. Ophuls reported that the examination of the specimen showed a spindle and small celled sarcoma. In September, 1917, sixteen months following the operation, the patient returned to the hospi-

tal with a large mass at the site of the amputation, with clinical evidence of pulmonary involvement and complaining of pain in the knees.

Roentgen examination showed fluid in the chest with multiple rounded shadows of increased density throughout both lung fields, typical of metastatic malignancy (Fig. 3). The hand and the feet showed marked club-

Fig. 11.

bing of the phalanges with irregular burr-like expansion of the distal ends of the phalanges. The metatarsals, metacarpals, tibiae, fibulae, femurs, the remaining radius, ulna and humerus, all showed a marked laminated ossifying periostitis which was sharply differentiated from the cortex of the bone; as a rule this periosteal reaction was confined to the diaphysis and was most marked near the distal ends of the bones. There was no involvement of the skull, vertebrae, scapula or pelvic bones. There was no apparent erosion of the joints or attempts of fusion of the reaction with the shaft as seen in some of the older cases.

This case is unique in that such a long period occurred between the original accident and the occurrence of a sarcoma, and the relative short time between the pulmonary involvement and the secondary hypertrophic osteo-arthropathy. It is generally agreed that the pulmonary disease must be of several years standing before the bony changes occur. One of Kessel's cases while showing symptoms of tuberculosis only for a few months, had had clubbed fingers for over a year. Malignancy of the lung is always of short duration, and it should be borne in mind that while clubbed fingers are as a rule the result of a chronic pulmonary condition, they may at times occur during an acute process, as pneumonia, and that the advanced stage of clubbed fingers, namely, hypertrophic osteo-arthropathy, may occur in conjunction with what may be a fairly acute condition.

I am indebted to Dr. Emmett Rixford of San Francisco for the privilege of reporting the above case.

REFERENCES

1. Locke, Edwin A. Secondary Hypertrophic Osteo-arthropathy. *Arch. Int. Med.*, May, 1915. Vol. XV.
2. Kessel, L. Hypertrophic Osteo-arthropathy. *Arch. Int. Med.*, Feb., 1917, Vol. XVII.
3. Hasbrouck, Hypertrophic Osteo-arthropathy. *N. York Med. J.*, 1898.
4. Saundby, R. A Case of Acromegaly. *Ill. Med. News*, 1889, Vol. II, 195.
5. Alexander, J. F. Hypertrophic Pulmonary Osteo-arthropathy, A Thesis. St. Barth. Hospital Report, 1906, Vol. XIII, 41.
6. Cagnetto, G. Sull' osteo-arthopatia con comitante ad alterazioni croniche del polmone. *Riv. veneta di sc. med.*, 1906, XIV, 15, 69, 97, 145.
7. Hall, D. G. Hypertrophic Pulmonary Osteo-arthropathy. *Edinburgh Med. J.*, 1005, New Series 18. IX, 127.

A TRUE CONGENITAL HERNIA IN THE RIGHT DIAPHRAGM*

By D. Y. KEITH, M.D.

LOUISVILLE, KY.

We shall find many cases of diaphragmatic hernia cited in the literature of the past five years, especially since the beginning of the world war. The major portion of these are traumatic in origin, and nearly all are seen in the left side and are of large size. We shall also find that a few are more common than is at present taught, many of the small ones not being *diagnosed at operation* or by the roentgen method,[1] many of the small congenital ones being intermittent. The one in this report certainly contained all of the stomach at one examination, but only the pyloric portion at the first examination.

This was a true hernia having a distinct sac, the sac containing fluid which was demonstrated on screen and plate. It was congenital in origin, the first symptoms appearing at the age of 18 months. There was no history of trauma.

We have met with only one case in the literature of true hernia on the right side,[2] which was 1½ inches to the right of the esophageal opening in the diaphragm.[5]

A case of right-sided eventration is recorded by Aronson [3] associated with Hirschsprung's disease. The symptoms appeared after a fall from a car, striking on the right side.

Jones [4] reports a case of eventration on the right side including 45 cases previously reported from *Johns Hopkins Hospital Bulletin.* The classification is as follows:

Three on the right side; forty-two on the left side; eight males; thirty-seven females.

Jones tabulates Eppinger's report of 635 cases of hernia and eventration:

TYPE	RIGHT SIDE	LEFT SIDE
True hernias	21	53
False hernias	34	527
Eventration	2	15
Ratio eventration to hernia	1 to 37.	

The leading symptoms were dyspnea, palpitation, cough, cyanosis, asthma after eating, pain between the shoulders, and various gastrointestinal disorders.

His conclusions were that no symptom is pathognomonic, and when the roentgen examination is negative, inferential evidence on the screen, such as high diaphragm, high position of stomach, high splenic or hepatic flexure, with a careful history and careful clinical examination, a positive diagnosis may be made of correlation of all the above.

Differential diagnostic points are:

EVENTRATION	HERNIA
High dome of the diaphragm with no loss of contour.	High diaphragm with loss of contour, a portion being regular, a portion blurred.
No gas shadows above liver shadow.	Gas or barium shadows seen above liver shadow.
More apt to be congenital.	Gastric deformity.
Paradoxical movement of diaphragm.	Obstruction.

To these we should like to add the presence of gas or fluid or both in the hernial sac.

CASE

History.—V. B., male, age seventeen years. Fair development, poorly nourished, rather anemic. His history is one of long suffering, beginning at the age of eighteen months at which time he was a very robust child (weight 25 pounds).

The only symptom was persistent vomiting, rapid loss of weight until he was marasmic, weighing only 7 or 8 pounds in a period of two months. For about six months he was free from symptoms; returned almost to normal weight with a return of vomiting. Since this time vomiting and loss of weight have been intermittent, the long-

* Read at the Midwinter Meeting of the Middle Section of The American Roentgen Ray Society Chicago, February 22, 1920.

est period being two years without symptoms. When first seen by us gastric disturbance had been nearly constant for six months.

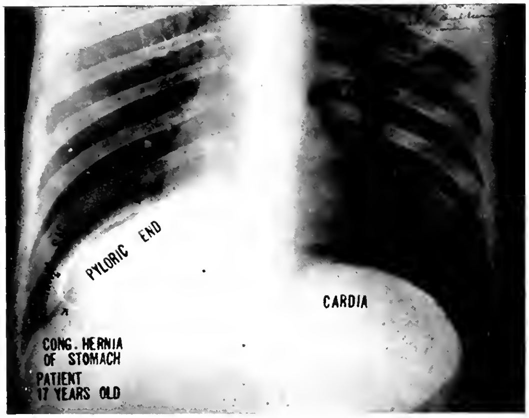


FIG. 1. Note the Shadow of Hernial Sac which Contains Gas and Fluid.

Examination.—January 11, 1919.

FLUOROSCOPIC EXAMINATION IN THE VERTICAL ANTERIOR POSITION.

Chest.—The cardiac and aortic shadows were normal. The diaphragm was mobile, being of normal contour on each side. The dome on the right side was much higher than normal.

Barium Meal.—There was a delay of the opaque bolus at the cardia with dilatation of the terminal 3 inches of the esophagus. The cardia was high, being under the ribs on the larged to the size and shape of a fetal head. left side. The barium shadow quickly en- In a few moments a small opaque shadow was seen to the right of the median line, which slowly became the size of a large orange, assuming a pear shape. The barium was on a level with the dome of the right diaphragm and could not be palpated, as it was above the margin of the ribs. Pencil shadows of barium were seen across the median line connecting the two opaque shadows. Gas and fluid were seen around the opaque shadows on the right. With vigorous palpation in the epigastrium, fluctuation was elicited. No barium was seen to egress into the duodenum.

A series of plates revealed the two opaque shadows, a fluid and gas shadow completely surrounding the shadow on the right side.

There was no change in the shadows at the end of one and a half hours. At the two hour period a small quantity of barium had entered the small gut.

Both pouches of the stomach contained barium at the six hour, twenty-four hour and thirty hour period. The pyloric pouch was empty at the forty-eight hour period. At least 25 per cent of the barium meal remained in the cardiac pouch to the left of the median line.

Colon Examination by enema was negative except a very high splenic flexure.

We believed we were dealing with a pancreatic cyst causing a double obstruction, gastric, by saddling the stomach, and duodenal by carrying it upward.

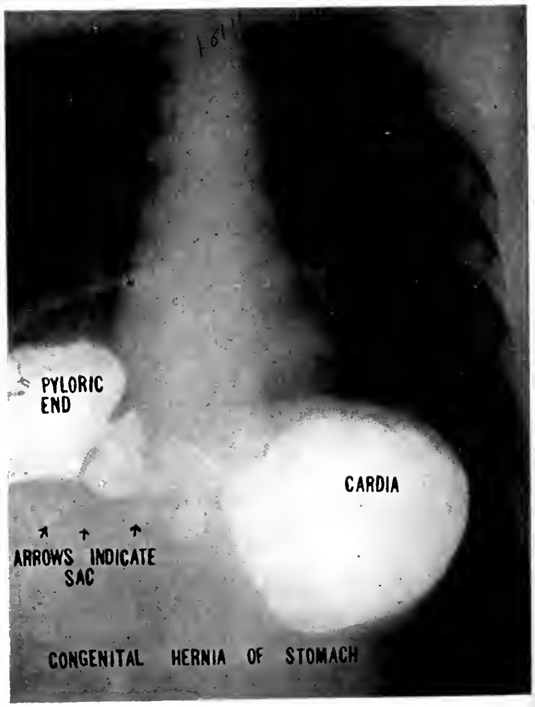
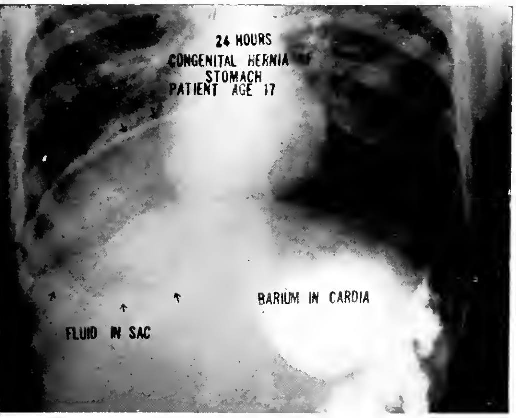


FIG. 2. Made Three Hours after Fig. 1, showing the Fluid and Gas in Hernial Sac better on account of less Barium in Pyloric Portion.

Fluoroscopic Examination three weeks later gave no delay of the opaque bolus in the esophagus, the barium crossing the me-

ian line high up, a shadow the size of a rge grape fruit appearing above the dome f the right side of the diaphragm, very uickly rolling downward and to the left.



IG. 3. 24 HOUR PLATE. Pyloric portion free of barium. Outline of Hernial Sac containing Gas and Fluid. This positive sign of true Hernia is not mentioney in any former reports.

Then the shadow to the right filled as at ormer examination. Evidently all of stomch was in hernial sac at the beginning of his examination. Fluid and gas shadows in he sac were of the same size and location s at former examination. A series of plates vere made including stereoscopic, all showng about the same size shadows as at forer examination, with no change in position.

Diagnosis.—Hernia of the stomach into he right chest. Distinct sac which contains luid and gas.

A few days later the abdomen was opened y Dr. Louis Frank to see that no adhesions xisted between sac and pleura. The entire tomach was in the chest, entering through lateral slit to the right of the spinal colmn. The opening was approximately 1¼ nches by 2½ inches. There was a distinct ac present, the size of a large grapefruit. f any fluid was present at operation it came into the abdominal cavity when stomach was pulled out of the chest.

Two weeks later the diaphragmatic opening was closed by the transthoracic route.

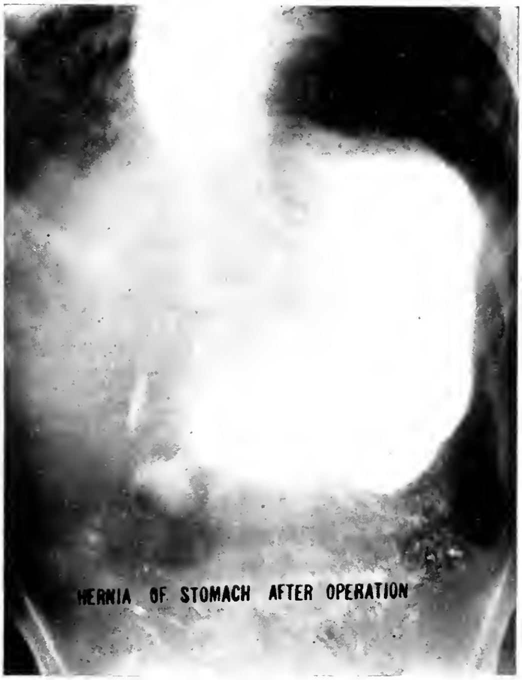


FIG. 4. ERECT POSTURE. Three weeks after Second Operation.

Recovery was uneventful, resulting in a complete cure. The patient now enjoys excellent health, weighing 150 pounds at present. He has developed a great deal since the operation.

Fluoroscopic Examination March 18, 1919, gave no filling defect in the esophagus, stomach or cap. Peristalsis was normal. Cap very flexible. There was moderate dilatation of the stomach and ptosis of about 2 inches.

REFERENCES

1. SORESI, A. L. *Ann. Surg.*, March, 1919.
2. SEIBERT. *Surg. Gynec. & Obst.*, October, 1916.
3. ARONSON, E. A. *N. York M. J.*, August, 1918.
4. JONES. *Arch. Int. Med.*, February 1916.
5. DE COURCY, J. L. *Ann. Surg.*, August, 1919.

THE BUCKY DIAPHRAGM PRINCIPLE APPLIED TO ROENTGENOGRAPHY

By HOLLIS E. POTTER, M.D.

CHICAGO, ILL.

In the columns of this Journal it was mentioned by the author that in fluoroscopy of the gastrointestinal tract much more clearness and contrast could be obtained by absorption of the scattered rays emerging from the body before they reached the fluoroscopic screen. A disk composed of interlaced strips of metal was rotated between the body and the screen, the design of the grid and the speed of rotation being adjusted so as to give little visibility to the metallic strips while performing the full function of a Bucky diaphragm at rest.

Believing that the constant presence of these scattered body rays presents the greatest direct limitation to the diagnostic value of our results in deep roentgenography, even more so than in fluoroscopy, we present the following arguments and results with a hope that roentgenologists and manufacturers may become convinced of the serious rôle played by object-secondary rays, to the end that it will soon be practicable for every roentgenologist to rid himself of their nuisance in his every-day work.

The accompanying diagram shows the source and direction of these scattered rays. They flood in from every side, striking a given point on the plate from every angle. Their action negatives in part the shadow-producing function of the primary focal rays, the combined result being a fog. This fog cannot be suppressed at its source by improvement in apparatus or technic, because it is a function of the action of rays on matter. It cannot be absorbed by filtration material without equally absorbing the primary rays. It remains, therefore, to bring about the absorption of the fog-producing rays between the time of their departure from the body and their arrival at the plate. The Bucky grid described in 1913 performs this function in an admirable manner, but leaves on the plate such an unpardonable shadow of the grid that no one would think of using it in practical work.

In our previous communication we mentioned the question of moving a grid as described by Bucky in such manner as to do away with the objectionable grid shadows while still performing the function of diaphragming off the scattered rays. It was brought out that to result in invisibility each and every portion of the plate should be covered by the components of the grid for exactly equal lengths of time. Failure to do this results in partial visibility of the grid, and shows in the form of various patterns on the plate. It is obvious that no linear, circular or irregular motion can be applied to the grid of square-shaped tubules such as was described by Bucky so as to result in the equal distribution of the shadows over each portion of the silvered surface. After failing to obtain complete invisibility with this construction and with others of a complex type, it was determined to find what amount of beneficial effect could be obtained by the use of parallel plates set on edge without the aid of cross members. The "clean-up" effect for the same spacing intervals was found to be less than with the cross-membered grid; but the opportunity of placing the strips much closer together by the parallel plan was much greater. It was obvious from the beginning that with parallel strips and a single uniform motion, there would result no shadows from the strips. After numerous experiments it was found that with ⅝ inch strips of type-metal spaced five to the inch, there was produced all the absorption of scattered rays that could be desired for practical work.

Working models were made and tested, the latest one of which is herewith described. Strips of type metal ⅝ inch wide, 1/50 inch thick and 2 feet long are mounted on a

form which is shaped so as to resemble a section of the shell of a cylinder. All metal strips are parallel and spaced by gutted wooden strips about 1/6 inch thick. This

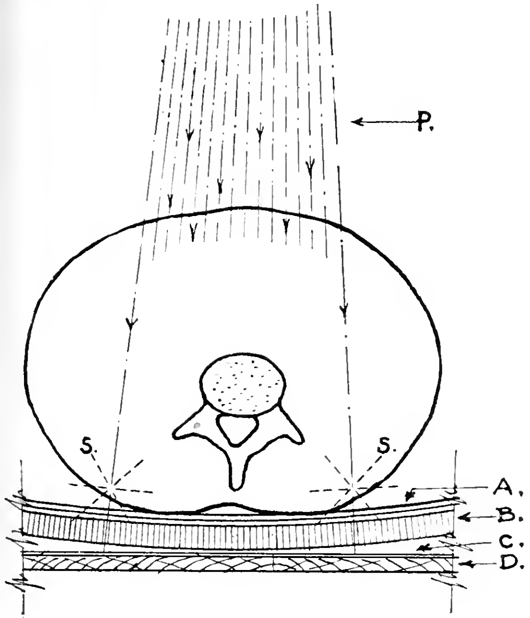


FIG. 1. Schematic representation of primary rays (P) and scattered rays (S) which are cut off by the faces of grid (B) before arriving at plate (C).

makes the strips with the spacers run about five to the inch. The curve put into the complex is such that the rays from a tube target 25 inches above, pass through the spaces without impinging on the sides of the strips, just the edges. (Fig. 1.)

This complex is mounted on roller bearings made to run on a curved track, so that motion is across the length of the strips, and the distance of movement about five inches. (Fig. 2.) The power used for movement is the weight of a mass of lead. This weight is hung from an equalizing rod, each of whose ends is attached by cable over pulley to a side of the movable grid. The movement is regulated in speed and made uniform in rate by an oil drag placed on the opposite side of the grid and attached thereto by a pair of cables and equalizers similar to that used for the weight. A valve in the piston controls the opening for the passage of oil and makes it possible for the grid to describe its arc of movement in any desired time between ½ second and 3¼ minutes. Above the grid is built a curved support for the patient. This is made of laminated wood and just allows the grid to clear underneath. Below the grid is a space for plates and screen holders. These are mounted, so that the grid members just clear them during the movement. The whole is mounted beneath a canvas-topped table with just enough slack to the canvas to allow patient to come in contact with the laminated wood over the "sieve." (Fig. 3.)

To operate, one places patient and plate in position, sets the oil drag in "down" position by trigger, and sets the valve for speed desired for the exposure. Just before starting the exposure the trigger is tripped by a pull on a string and the "sieve" set in motion. The exposure must be completed before the sieve comes to a stop, otherwise the strips cast their shadows.

It is not necessary that the strips be made to pass over the plate at any great speed, nor is it advisable. With the grid built as above it is found by experiment that one does not obtain uniform invisibility of the grid unless the movement is an inch or more during the exposure. In using the grid we usually aim to have a moment of from 2

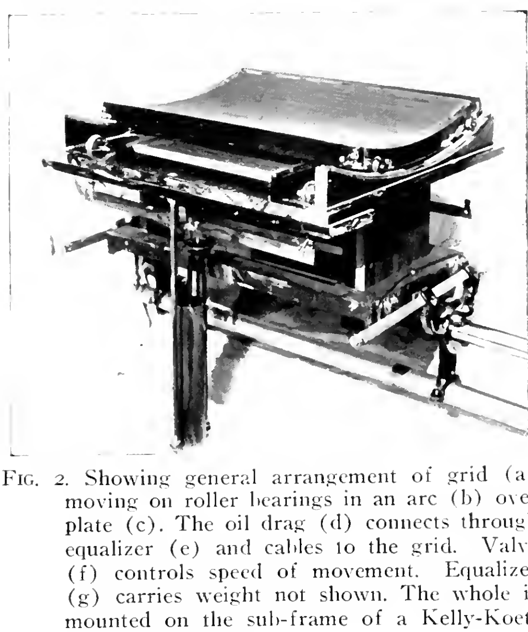


FIG. 2. Showing general arrangement of grid (a) moving on roller bearings in an arc (b) over plate (c). The oil drag (d) connects through equalizer (e) and cables to the grid. Valve (f) controls speed of movement. Equalizer (g) carries weight not shown. The whole is mounted on the sub-frame of a Kelly-Koett fluoroscopic table.

to 4 inches, for this always produces complete invisibility.

The exposure time for plates made with this arrangement is somewhat increased by

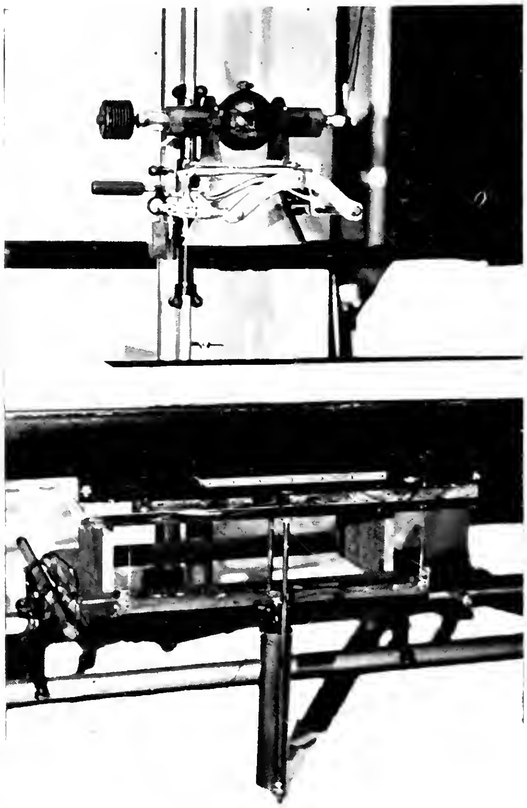


Fig. 3. Diaphragm Arrangement in Position for Use Under Canvas-Topped Table. Tube 25 inches above.

the absorption of some of the direct rays by the edges of the metal strips and by the wood used above the grid and for spacers. This loss of speed is compensated for, however, by the fact that with this arrangement it is possible and advisable to use rays of a greater penetrability than by plain radiography. With ordinary x-ray emulsions a full five-inch spark equivalent is used without obtaining on the plates that objectionable fog so common with this gap. At the same time the detail in all osseous structures is greatly increased by this full penetration, and the markings in the softer structures so often glutted out by aberrant rays ar preserved.

The field of usefulness for this diaphragm ing instrument is, as would be expected, i

Fig. 4. Print of Spine, etc., illustrating freedon from grid shadows obtainable by uniform mo tion of grid of construction described.

the roentgenography of the deeper struc tures mainly lying in the abdomen and pel vis. For anteroposterior and lateral spines i is especially needed, and the roentgeno graphic quality obtainable in the exploratio of these structures would more than justif its use in every laboratory. For urinary cal culi and gall-stones its use makes quit visible and distinct those calculi of semi dense composition which are so often doubt ful on routine plates. One of the most grati fying uses is in connection with especiall corpulent individuals. Here the scattere rays reign supreme and account for most o the silver actually reduced on the averag roentgen plate. Absorption of these aberran rays gives us radiographic results of th lumbar spine that we formerly considere impossible to obtain.

Another phase of usefulness lies in th

ncreased size of field which can be covered vithout loss in diaphragming effect. The clean-up effect over every portion of a 14 x 17 plate is scarcely distinguishable from

Fig. 5. Print of Spine Showing General Quality Obtainable with the Grid. Half-tone illustrations cannot be expected to show the intimate details of bone visible in the plates.

hat obtained when adding a small cone and ncluding a small area only. This allows the roentgenography of the entire urinary tract at once, the entire pelvis at once, or large sections of spine in any direction without reducing the quality at any one point.

So far we have used it but slightly on sinuses and gastrointestinal work, although n both these regions its use is indicated. In the latter field the crudeness of our apparatus requires a very sharp coordination between exposure and grid movement. After the installation of a magnetic release for the grid we expect the apparatus to be ready for routine use in rapid exposures, and the results so far are so brilliant as to justify further experiment.

[Note: Before Dr. Caldwell's death he visited our laboratory and was shown this apparatus and some of the results. He told us at the time that he was informed that Bucky, who lives in Germany, had been experimenting with moving grids of some type to obtain the same

Fig. 6. Print of Spine Showing the Unusual Contrast Obtainable in Person of Light Weight. With intensifying screens these contrasts can be made so violent as to be objectionable.

invisibility with suppression of secondaries toward which we have been working. In Cincinnati, at the February, 1917, meeting, our present apparatus was described and results shown. Further mention of it has not been made until recently, when visiting roentgenologists urged that it be written up for the Journal.

It has been difficult to learn what Bucky may have accomplished along this line, but certainly there has been no announcement that a practical working method of suppressing object-secondaries has been brought out. The method above described is fairly simple and it seems time that manufacturers should make it available for our routine work.]

DIAGNOSIS BY THE HELP OF X-RAYS OF CIRRHOSIS OF THE LIVER

By A. HOWARD PIRIE, M.D.

MONTREAL, CANADA

By comparing these two radiographs one can make out certain differences. Fig. 1 is made of a normal individual whose peritoneal cavity was injected with oxygen according to Stewart's method. In it one can make out the outline of the liver as a smooth sharp line. It can be seen only on the right side of the spinal column. On the left side the outline of the spleen is seen distinctly. There is a space on each side separating the upper surface of the liver and spleen from the under surface of the diaphragm. This space is filled with oxygen as the patient is in the upright position. The quantity of oxygen present is about a litre.

Fig. 1. Normal Abdomen taken in the Upright Position after Injection of a Litre of Oxygen showing the smooth sharp outline of the Liver and Spleen.

Fig. 2. Cirrhosis of the Liver taken in the Upright Position after the Injection of a Litre of Oxygen showing the smooth outline of the Spleen, the rough nodular double and triple outline of the Liver and the level of the fluid in the Abdomen an inch higher on the right side than on the left.

Fig. 3. Radiogram of an excised Cirrhotic Liver from the Museum of McGill University. It shows the irregular outline of the Liver with the same distant mountain range effect as seen in the radiograph of the patient referred to in this article.

On comparing Fig. 2 with Fig. 1 one sees in Fig. 2 the same organs demonstrated, namely, the diaphragm on each side with the oxygen below it, and the smooth outline of the spleen on the left side. At this point the difference begins between the two pictures.

The upper surface of the liver can be seen on the left side as well as on the right side. And now comes the point of greatest difference. The outline of the liver instead of being a smooth line is rough and nodular. Its rough outline is not single, but double and triple in places; the appearance is what one would expect to see in an *x*-ray picture of a hobnail liver. This patient had ascites, and the level of the fluid is seen on each side. It is an inch higher on the right side than on the left.

SUMMARY.

The irregular outline of a hobnail liver can be shown with *x*-rays by injecting into the peritoneal cavity a litre of oxygen and making an *x*-ray plate in the upright position. The patient suffers no discomfort in this position.

MALIGNANT ABDOMINAL TUMOR CLINICALLY CURED BY X-RAY

By LOWELL S. GOIN, M.D.

Associate Roentgenologist, Battle Creek Sanitarium

BATTLE CREEK, MICH.

IN June, 1916, Mrs. M. B., age fifty, was referred to me with the following history.

History preceding the present condition was of no interest; late in 1915 she had begun to have abdominal pain, with an increase in the size of the abdomen. In February, 1916, she was seen by Dr. Richard Wilson, Martins Ferry, Ohio, who advised an exploratory operation. In March, 1916 she was operated at the Martins Ferry City Hospital. The abdomen was opened, and a large, very vascular tumor mass was found, which was inoperable. The tumor appeared to spring from the mesentery, and a slight incision in it produced an alarming hemorrhage. On this account no section was made for pathological study. The surgeon stated, however, that he felt not the slightest doubt that the growth was an angiosarcoma. After the operation her condition grew steadily worse; the abdomen increased in size, and she suffered great pain. She was referred to me for *x*-ray treatment with the idea of getting some relief from the constant pain. The patient's condition at this time was very bad. She could not walk, slept but little, had no appetite, and was in constant pain. Her weight was about normal, probably because the great tumor masss made up the loss in flesh. She measured 48 inches around the abdomen, at the waist line. The abdomen was hard and rigid. Her daughter was told that there was some hope of relieving the pain, but that no improvement could be expected, and treatment was undertaken. The abdomen was marked off into twelve areas anteriorly, and eight posteriorly, each area receiving 4½ milliamperes, backing up a 9 inch parallel gap, using a filter of 5 mm. of aluminum and a layer of sole leather for 5 minutes at a target skin distance of 8 inches. The first three series were three weeks apart, the remainder were at four week intervals. After three series the patient's condition was not improved, except that the pain was not so constant. When she returned for the fourth series, the pain had ceased, her general condition was much improved, and her abdomen had decreased in size three inches. After eight series, the abdomen measured about 30 inches in circumference, the patient was free from pain, ate and slept well, and was able to do her own housework. Two more series were given; the improvement continued steadily, and the girth of the abdomen decreased to 23 inches, which was about normal for the patient. At the present time (September, 1919) she is well, able to do her own housework, and has had no sign of recurrence.

PLAN OF A BUILDING FOR A MODEL X-RAY LABORATORY

By J. D. MORGAN, B.A. (Cantab.), M.D., C.M. (McGill),

Radiologist Ross Pavilion, Royal Victoria Hospital

MONTREAL, CANADA

THE demand for the *x*-rays as an aid to diagnosis in almost every field of medicine or surgery, has rendered the installation of an *x*-ray department a necessity in every hospital. While the *x*-rays were in their "teens" the apparatus required to produce them was regarded as the expensive toy of a crank. By the time they "came of age" an *x*-ray installation was considered a necessary evil in most hospitals. Now, however, an *x*-ray department is regarded as indispensable in every hospital. There is indication, also, that the future holds great promise of fuller development of the usefulness of *x*-rays in both diagnosis and therapy.

Before their true value had come to be recognized, any corner not needed for other purposes was considered good enough to house the *x*-ray apparatus. With the growth in importance of the subject, and the increase in delicacy and cost of the apparatus, the requirements of the *x*-ray department are receiving more and more consideration in all modern hospitals. Too often, however, in the construction of a new hospital, it is left to the architect, or to some building committee, to decide the position and arrangement of the department, and the advice of the roentgenologist is not sought in this important matter. Where work of such technical and variable character is to be carried on, it is only reasonable that an expert should be consulted as to the number and arrangement of the rooms.

While an attempt will here be made to outline the requirements of a model department, it is recognized that no plan can be made which will prove satisfactory under every condition. Among matters of importance which must be considered in each case are the architecture of the building, the size of the hospital, and the nature of the work to be done in the department. The mone available for equipment and maintenanc will also have a bearing on the determinatic of final plans. It has frequently been state that the *x*-ray department should be place next to the operating theater or the ward This is more true in theory than in practic Indeed, several objections may be mer tioned. For example, a certain amount c dust and noise is created in the neighborhoc of a busy *x*-ray department by the constar arrival and departure of patients, and by th operation of the apparatus. A better ru would be to place the department in a centr position, and at the same time as near as po sible to the out-patient department, ar where, no doubt, it would also be in proxin ity to some, at least, of the surgical c medical wards. If the routine is establishe that all skiagrams shall be examined by th surgeons, in consultation with the roentger ologist, before operation, very few of th plates will be required in the operating thea ter. Should this not be the case, howeve they can readily be sent there irrespective c the distance from the department.

The ideal laboratory here suggested depicted as contained in a separate two-stor building, and of sufficient size for a ho pital of 500 or more beds. The outside meas urements are 78 feet by 83 feet. On the firs floor the operating rooms, dressing room etc., are arranged next the outside of th building. Internally they open on a passag 8 feet in width, which in turn runs aroun a centrally placed dark room. On our left, a we enter, are the stairs and an electricall driven elevator. The passage widens out op posite the latter, giving more room for th maneuvring of a stretcher or bed. At a angle facing the entrance is a blank wal very suitable for notice boards, or a mem

*Thesis presented with application for membership in The American Roentgen Ray Society, 1920.

orial tablet. On the opposite side of the passage to the elevator is the general office. A counter, with sliding windows above, divides this from the passage. The room contains a desk, filing cabinets, etc., to hold the records of the department. There is also a small switchboard by means of which the principal rooms in the department are connected by telephone.

Continuing along the passage the first room to our left is Operating Room I. This room is used for dental radiography. It contains a special dental apparatus, a filing cabinet, a desk, a wash basin, etc. Opening off it is a dark room for the developing of the dental films. A large closet on the opposite side of the passage, provides storage space.

The next large room, continuing along the passage, is Operating Room II. This room is intended for general radiography, and, in addition, for the setting of fractures with the help of the fluorescent screen. It contains a wooden radiographic table, with protected tube box below for fluoroscopy. A special device is attached to the table, by means of which traction can be obtained while reducing fractures. The room also contains a separate tube stand, and a cabinet for instruments and plaster bandages. A door on one side opens into a dressing-room, and, on the opposite side, is a room which contains the controlling switchboards, a large lead-lined plate box, and the transformer. This latter stands near the outer wall and, for the sake of quietness, is separated from the control room by two glass-paneled doors. A dressing-room opens from one side of this room.

Directly in the corner of the building, and convenient to the operating rooms, is a waiting room. Following this is another set of rooms, Operating Rooms III and IV with their accompanying dressing-rooms, intervening switchboard-room, and machine room. In addition to the radiographic tables and tube stands, they each contain a horizontal or vertical stereoscopic plate changer.

In the corner of the building is another waiting-room, and next to it, a dressing-room, and Operating Room V. In this room barium enema examinations and serial radiographs of barium meals are made. It contains a table (with a tilting top, and tube box below), a tube stand, and a Cole table. There are also a bench and sink where the barium enemata are prepared. In one corner is a small room for the transformer. A branch of the main passage lies between this and the next group of rooms. A small toilet room opens on it.

Operating Rooms VI, VII, and VIII are devoted to urological work. Patients can be catheterised here, and radiographed without being moved. A toilet room opens off Operating Room VII, and there are dressing-rooms in connection with them all. Each room is provided with an *x*-ray table especially designed for this work, a sterilizer, an instrument cabinet, a wash-basin, etc. One "Bedside Unit" with radiator-type Coolidge tube (30 ma.) is sufficient to do the work in these three rooms. It can be rolled from one to another and connection made with a specially arranged socket in each.

Operating Room IX is the fluoroscopic room. It forms part of the central block of rooms. It contains a table (with tube below), and a vertical fluoroscope, for horizontal and vertical fluoroscopy, respectively. A dressing-room occupies one corner, and, diagonally opposite, there is a small room in which the barium meals are prepared.

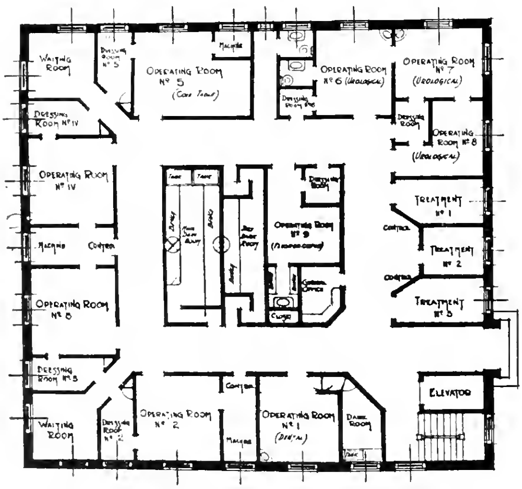
The remainder of the central block is made up of a large, main dark-room, in which all radiograms (with the exception of the dental films) are developed, and a smaller "dry" dark-room where cassettes are loaded and unloaded. Plates can be passed into the main room, either from the "dry" room, or from the passage, by means of revolving "dumb-waiters," thus rendering it unnecessary for the technicians to enter the dark-room.

Three lead-lined treatment rooms are placed in a row, next to Operating Room VIII. The two outside rooms are large

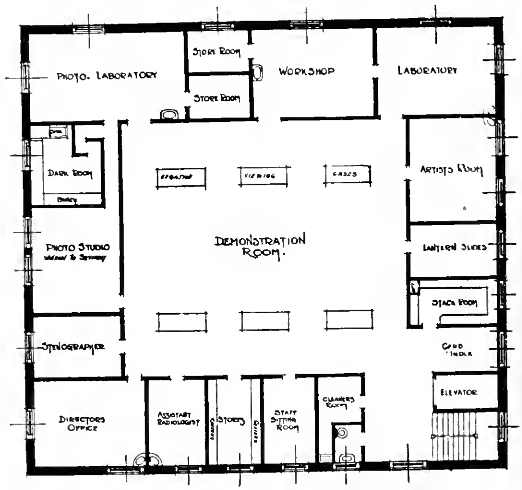
enough to take "bed" cases, the middle one, smaller, and suitable for "walking" cases.

In an alcove outside these rooms are the controlling switch-boards, and a clear view of each room is obtained through a "lead-glass" window placed at the side of each control board.

The main feature on the second floor is the large central demonstration room. It measures 44 feet in width by 48 feet in length. A row of large, double-sided viewing cases runs down each side, standing some 8 feet away from the wall. The space in the center of the room can be filled with benches and used for demonstrations or lectures. The walls are covered with pictures of interest, and show-cabinets containing lantern slides and specimens are placed about the room. This idea received unconscious, but welcome, corroboration in an article by Dr. A. E. Barclay in the November, 1919, number of the *Proceedings of the Royal Society of Medicine*, London, England.



FIRST. FLOOR.



SECOND FLOOR

Next to the elevator is an alcove where the card-index files are kept, and next to this the stack-room where the negatives are filed away. By means of a small lift plates are sent up to the stack-room from the general office below. Next, again, is a room containing a collection of lantern slides, prepared both from radiographs and photographs, of subjects of scientific interest. During the course of a lecture or demonstration these pictures can be projected, by means of a lantern, through a window cut in the wall of the demonstration room, on to a screen placed on the opposite wall.

The next room is the artist's studio, where diagrams, half-tone cuts, etc., are prepared for publication, or lecture purposes. Next, again, is a large room where research work is carried on. Connected with it is a workshop where new apparatus is prepared and old apparatus repaired. A photographic laboratory occupies the corner of the building, where all kinds of photographic work is done, namely, the photographing of interesting cases or specimens, the making of enlargements or lantern-slide reductions, microphotography, color photography, "moving-picture" photography, etc. A dark-room and studio form part of this department.

The opposite corner is occupied by the director's office, on one side of which is a room for the stenographer, and on the other side, an office for the assistant radiologist. Next to this is a store-room, and next, again, a sitting room for the staff. A cleaner's room, for mops, brooms, etc., and a lavatory, complete the department.

It may be remarked, and with some justification, that much more is included in this building than ordinarily constitutes an x-ray laboratory. In fact, with the exception of a plate-viewing room, the first floor contains all that is actually required. An attempt has

been made, however, in designing this model laboratory, to keep in mind a broader view.

There is hardly a department in a hospital at the present time that does not depend on the x-ray for assistance in diagnosis. So true is this that one could, without exaggeration, modernize an old saying, thus: "All roads lead to the x-ray department." This is applied in no boastful spirit, but rather to point to the great responsibility which now develves on the x-ray department. It is the more fully to meet this responsibility that the additional rooms on the second floor of the model building have been considered a necessary addition to the purely clinical requirements of the department.

As a direct result of its close association with all the other specialties, the x-ray department should become the common meeting ground of the members of the staff, both for consultations, and even socially. In a teaching institution this should apply with even greater force, for demonstrations can then be held where the hospital's collection of skiagrams, photographs, etc., are most readily available. It was with this object in view that the large demonstration room was designed. By placing it on a separate floor from the operating rooms the routine work of the department is not interfered with in any way. Large viewing boxes standing near the walls permit of the examination of the recently made roentgenograms, while demonstrations and lectures can be given in the center of the room. Opening on it is a stack-room where the negatives are filed away. A large room is provided as a laboratory where original work is carried on. No department can show progress unless provision is made for this. A workshop where old apparatus can be repaired, or new apparatus made, is a necessary adjunct.

The photographic department and artist's room might be considered as outside the scope of an x-ray laboratory. To a certain extent this is true; but if one associates them with the idea of a central demonstration room, where pictorial records of various sorts are required, they seem to fall quite naturally into the scheme of a model department. In the accompanying floor plans no attempt has been made, for the sake of clearness, to indicate the position of the apparatus.

ALVEOLAR INFECTIONS OF DENTAL ORIGIN AS SEEN BY THE ROENTGENOLOGIST*

By H. W. DACHTLER

TOLEDO, OHIO

THE problem of alveolar abscesses needs intelligent discussion at this time, as we are being forced to the conclusion that many of the diseases of hitherto unknown origin are probably due to chronic infections of the blood and blood-forming organs.

Pernicious anemia, the leukemias, and perhaps Hodgkin's disease come under this class, while there are many better known conditions in which chronic infection is definitely known to be the sole exciting cause. With this more clearly understood it is quite evident that focal infections of the alveolar process are largely medical and not dental problems, and the physician and not the dentist is to be the court of final jurisdiction.

In the past there has been too much controversy on this subject, and the physician is as much to blame as the dentist for the misunderstandings that have existed. The dentist has pointed the finger of scorn at the medical man who has had the teeth extracted from a patient with chronic arthritis, only to find that the arthritis was not cured. The dentist, because he has seen many patients with definite abscessed teeth who were without visible evidence of disease, has often insisted that the physician is a fool to lay so much stress on dental infections. Perhaps for these reasons some of the dentists have been unable to see clearly on the subject, while some seem hopelessly blind.

There has been so much antagonism from a large number of dentists, regardless of the writings of many of their leaders, that intelligent discussion of the patient's condition was impossible. If we can clear up some of the mist that has obscured our judgment in the past it will indeed be fortunate for the laity.

In the first place it must be definitely understood that certain medical conditions are due to infection, but that dental infections are not the sole cause of such conditions. The physician who sends his patient for a roentgen examination of the teeth because they are suspicious, without first examining that patient for all sources of infection, is as negligent as the dentist who allows his patients with a number of devitalized teeth to drift along until they consult a physician and are found with a serious lesion due to focal infection. The physician who rushes into print with a series of case reports showing that those patients who had had the teeth extracted for an infectious arthritis were only cured when their tonsils were removed, does as much harm as the physician who was responsible for the extraction of the teeth. In fact, by his writings, he probably does more harm. I can cite a long list of cases that had had the tonsils removed first and were only cured when the teeth were intelligently extracted. These men were only high enough in mental outlook to see over the bottom rail of the fence.

The problem of dental infections is a hard one from both the diagnostic and medical aspects. It is common practice in diagnostic laboratories using the roentgen ray to make a set of ten films to cover the teeth, and on these it is presumed to base a final opinion. In many cases this is sufficient; but in many medical cases, where there are a number of dead teeth, it is inadequate. Any roentgenologist can show cases in which three films of a single tooth were made, from one of which an absolute diagnosis of an abscess could be established, and in which the other two failed to show it definitely. This does not mean that the technique was faulty, but that it took a certain angle, many times not the normal one, to render the abscess clearly visible. In some cases it is necessary to resort

* A paper read at a combined meeting of The Toledo Academy of Medicine and The Toledo Dental Society, January 23, 1920.

to plates on the outside of the jaw to determine definitely whether or not an abscess exists. Again, the patient's mouth may be of such shape that it is impossible to get films of some of the teeth which can be said to be absolutely diagnostic. Also, in the upper molar region, the roentgen film only may never be able absolutely to rule out an abscess. Owing to the angle that the film makes with these teeth and the angle at which the tube must be placed to show the roots at all, some abscesses cannot be detected. Again, some patients cannot tolerate films in the mouth owing to persistent gagging, while others are referred to the roentgenologist so ill that good films are unobtainable. Some are so crippled from an arthritis that they find it impossible to hold the film in the mouth, and some have nerve lesions that make it impossible to immobilize them during the one or two second exposure. Owing to the above, dental roentgen diagnosis is in the same class as the Wassermann test—positive results are exceedingly valuable; negative results may be misleading and therefore dangerous.

Having mentioned briefly the difficulties from the mechanical side, the more important problem of interpreting the films needs discussion. The dental film is not a diagnosis. It is worth as much, and only as much, as the roentgenologist's judgment and experience are worth. All roentgen film plates, if properly interpreted, are interpreted largely in the light of past experience. Perhaps five years ago, when to make a diagnosis of an alveolar abscess at the apex of a tooth was quite likely to bring down upon the head of the roentgenologist the wrath of the patient's dentist, I ventured to assert that the roentgen study of changes in the bones due to infection had been going on for at least a dozen years, and that many problems had been worked out in that time and proved by clinical and microscopical methods. In my early dental work my conclusions were based largely on past experience with infections of the other bones of the body. I could see no reason why infections of the alveolar process should not produce the same bone changes as those produced in other bones by infection and should not be subject to the same processes of bone atrophy, absorption and repair. At that time I stated that areas of bone atrophy with the disappearance of the lime salts at the apex of a tooth always meant infection in some stage, and that the infection could only be said to be eliminated when the bone atrophy disappeared and there was a return of normal bone structure. An extended experience has served to strengthen those opinions.

Now as to the cause of these infections: Whenever the nerve of a healthy tooth is killed and the root canal filled, and the tooth shortly after shows an abscess, I am of the opinion that it was infected at the time the operation was performed. I have followed quite a number of these cases from the first, have seen the gradual development of the abscess, the development of secondary manifestations and their immediate subsidence following extraction of the tooth. Some of these patients had definite clinical evidence of infection, such as slight chill, slight rise in temperature and local pain within twenty-four hours after sealing the root canal. Sometimes the pain subsided within forty-eight hours, and the pain and reaction were attributed by the dentist to the operation and not to infection. Many others seen later gave a definite history of early reaction which, to me, suggested infection. If a tooth is definitely proved to be without an abscess three months after treatment I think it can be disregarded, unless the tooth is subsequently opened or receives further dental care. Neither is the fetish of filling a tooth to the very apex of any consequence *per se*. I have seen many teeth that had had the nerve extracted years ago and the root imperfectly filled that were as free from abscesses as teeth devitalized today. It is probably true that a root perfectly filled to the apex shows more careful work and better dentistry, but it is also true that in many cases the work necessary to do this means greater danger of infection and poorer ultimate results. Of the two methods, the dentist who removes the nerve and promptly fills the canal and seals

up the tooth permanently will probably infect less teeth than the dentist who works over it for a week or two, opening and sealing it a number of times.

It has been conclusively proved that bone operations require the most careful aseptic technique of anything the surgeon undertakes. Repeatedly it has been demonstrated that surgeons who can open the abdomen with almost unfailing good results cannot operate on bones with the same technique without infecting them. This being the case, it is not to be expected that the dental surgeon can enter the alveolar process without infection in many cases. He works in a room that is never sterile; and he is working over the mouth, which harbors more varieties of pathogenic organisms than any other part of the body. I fancy he will be somewhat handicapped in using a face mask on his patient even if he wear one himself. It would seem that absolute asepsis is practically impossible. I cannot concur with those who believe that the infection is a metastatic one, or that it is nature's way of removing a dead substance which the body refuses to tolerate. The way these abscesses extend from the apex of a tooth deep into the alveolar process does not warrant this conclusion.

As to the danger from alveolar abscesses, there can be no question at this time. There are few physicians who have not seen the dangerous results that follow alveolar infection in many cases and the prompt subsidence of the secondary manifestations that followed the elimination of the primary focus of infection. This has many times resulted in the physician's overlooking the possibility of infection from other sources, and, where abscessed teeth are found, advising the patient that the removal of the teeth will cure the condition. Patients suffering from the effects of infection should be informed of the nature of the trouble, and an honest effort should be made to locate and remove all primary foci in an effort to effect a cure. There is no reason to expect that all secondary manifestations will be cured even when the original cause of the trouble is located and removed. Those due to toxins probably will, but the active metastatic infections may not, and this is a strong argument against waiting for secondary manifestations to appear when a primary infection is located. Owing to the nature of alveolar bone, infections in it tend to enter the blood stream early and with certainty. There is no mucous membrane that tends to wall off an alveolar abscess and localize it, such as is found in parts of the body that are ordinarily subject to infection, and secondary manifestations occur with greater certainty.

Now as to the treatment of alveolar abscesses, I think most dental surgeons will agree that no tooth should be devitalized unless decay has made it absolutely necessary. When devitalized, it should be carefully watched long enough to be certain it is not infected, and when this is proven one need not fear infection later. Here we have one of the difficult problems in dental roentgen diagnosis. I have seen some very bad secondary infections in early cases in which perfect films showed such slight changes they almost escaped notice. We must be especially careful of slight changes extending from the apex up one side of the tooth and with very little bone destruction. I have seen such cases, which incapacitated the patient and in which the patients were promptly cured by extraction of the tooth.

From the medical standpoint the patient who is seen with evidence of focal infection must have all sources of infection, as far as possible, located, including, of course, the teeth. Here we shall digress to point out that patients with apparently normal teeth will occasionally show a badly abscessed tooth, with nothing in the history to indicate that a tooth has a dead nerve or is abscessed. This makes it imperative that all teeth be examined, and not merely those known or suspected of being dead. Partial examination of the teeth in medical cases is to be condemned, as patients think they have been fully examined, and since they are misled they may later mislead any physician consulted.

As the size of the abscess bears little relation to its danger it is sometimes impossible to determine which of several abscessed

teeth is doing the most harm. In the presence of serious lesions, all should be removed that are definitely abscessed, and if the patient does not recover we will go farther and say that all dead upper molars should be extracted, as they are often much worse than the dental roentgen film indicates. However, the dentist has a right to insist that other infections be eliminated.

Where patients have serious lesions caused or aggravated by focal infections, the dentist should not presume to advise patients not to have abscessed teeth extracted, in the light of our present knowledge. While it will probably cause a controversy, as even the dental surgeons are not in accord on the subject, I do not feel that the dentist is justified in attempting to cure an abscess by treatment through the root canal alone. While I have seen a few definitely cured by this method, it is too uncertain, it takes too long to be of service in medical cases, and the risk is too great. More can be accomplished by amputating the root, provided all of the denuded portion can be removed; this promptly stops absorption and establishes efficient drainage. Fortunately the removal of the abscessed tooth will usually be all that is necessary to effect a cure. The removal of the diseased bone by the curette may facilitate healing, and is sometimes necessary to prevent bone abscesses from forming deep in the alveolar process.

Owing to the growing conservatism of the dentist we shall not have to deal with so many of these cases in the future; but how are we to handle the old cases? In trying to give these patients intelligent advice I have come to group conditions under three heads, viz., active abscesses, low grade abscesses and probably inactive lesions. With the exception of the upper molars most apical infections can be divided into these three classes. Active abscesses should always be eliminated. In the low grade abscesses the medical condition should be the deciding factor. Without doubt the conservation of the patient's health demands their removal; but in the absence of any definite evidence of disease, if the patient elects to run the risk of keeping them, he is entitled to the privilege. Probably some women will always take the risk of having their lives shortened rather than to have an incisor extracted, but when patients come to understand, as they are rapidly doing, that these low grade infections are a constant menace to health, both directly and by a lowered resistance to other infections, they will probably elect to have them removed. While I paid little attention to it at the time I recall vividly a statement to the writer by Sir Arbuthnot Lane in 1912 wherein he said he was convinced that chronic infections and infected teeth must be considered in the problem of carcinoma of the breast. In an experience with about three hundred such cases I am appalled at the percentage of these patients with a number of low grade apical infections.

Of the apical infections classed as inactive lesions quite a number are seen. It is seldom that one is justified in ordering such teeth extracted regardless of the contention of Dr. Novitzky. The changes noted in the alveolar process are entirely different from those found in the "low grade abscesses." Always the slight bone destruction produced has been followed by bone repair; sometimes sclerosis and no definite cavity is present. The roentgen picture, while not normal, is quite different from that of the low grade abscess. In the low grade abscess the pocket may be sterile, or it may have become walled off, in which condition it may be harmless; so by no means open such a tooth for treatment, as admitting oxygen may reactivate it, or you may reinfect it with disastrous results.

In concluding I want to emphasize the value of a careful history of the dental work done.

This often shows that the patient's complaint dated from shortly after some work was done on one of these dead teeth. An inactive abscess had probably become an active one.

CANCER AMELIORATIONS AND CANCER IMMUNITY*

By A. F. HOLDING, M.D.

MADISON, WISCONSIN

PRESENTING a paper on roentgen treatment to such an experienced group of men as this, I feel would be quite as uncalled for as making suggestions to the Tiger of France on how to win the war. It is the purpose of this paper not to present anything new, but merely to correlate the facts we gnow about the treatment of cancer, and to make a plea for the cooperative employment of surgery and radioactivity to assist nature in establishing cancer immunity in our patients.

STATUS OF TREATMENT

While many things that I may say about cancer may be challenged, there is one thing I will say without any fear of successful contradiction: There is no specific cure for cancer. This does not necessarily mean that cancer cannot be cured, but it does mean that there is no single measure for treating cancer that has been so successful that it alone is recognized the world over as the cure for cancer in all stages, and that cures all but exceptional cases. On the contrary, it is the exceptional case of clinical cancer that is ever cured.

Just as surely as it is true that "a doctor never cured a disease," so it is true that surgery, *x*-rays, radium, toxins or vaccines, never cured a case of cancer. Nature can, and has, cured cancer spontaneously, sometimes with, sometimes without medical or surgical assistance. We should not lose sight of this fact. Nature does the curing when a case is cured, and the doctor, the surgeon, or the radiologist, at best, is merely an assistant, an adjuvant, a synergist, if you please. Let him beware lest his ambitious ardor ever lead him into becoming an antagonist, a handicap, or an annihilator of nature. When cases of cancer are cured they get well because the cancer has been totally removed or the case has developed cancer immunity, whatever that means—and it ought to be our task to find out what that does mean.

In the past twenty years, we have seen some cases develop cancer immunity after a local removal by surgery in its various forms, whether incisive, caustic, or radiologic. In the past ten years, we have seen, in addition to the surgical results obtained, many uniform improvements in cases of cancer brought about by radiology. This leads us to believe that with surgery plus radiology, we are in a better position to treat cancer than ever before, and stimulates us to try to find out what cancer immunity is, and how to induce it.

We all know that cancer is increasing; that surgery cures 75 per cent to 80 per cent of cases of cancer, providing these cases present themselves and are operated before a clinical diagnosis can be made; that this percentage immediately drops to 25 per cent of cures if the cases present themselves after the cancer has developed so it can be recognized clinically.

The master surgeons of the world admit that practically out of ten cases of cancer of the lip, breast, stomach or uterus that present themselves for surgical treatment seven die.

We know that while incisive surgery is the commonest form of treatment used, in selected cases, coagulation (bloodless) surgery, whether by caustics or various forms of cauteries, presents certain advantages over incisive surgery; that in the light of surgical statistics in cancer, surgery is only *a* cure, and until *the* cure of cancer is found, surgery needs synergists; that among the synergists, radioactivity is deservedly the most popular, because it has been proved in animals to have selective, inhibitory, and destructive action on:

* Read before the Middle Section of THE AMERICAN ROENTGEN RAY SOCIETY, Chicago, Feb. 21, 1920.

1. The nuclei of cells;
2. The cells of the lymphatic system;
3. Edothelium;
4. Certain glands, such as the ovary, testicle, thyroid, prostate, parotid, mammary and pancreas.

This action has been proved to hold good in human beings, as evidenced in cases of lympho-sarcoma; basal cell epithelioma; tumors composed of embryonal cells; tumors nourished by endothelial capillaries; carcinoma testis of teratoid origin; mammary carcinoma; adeno-carcinoma of the ovary; goiter of the exopthalmic type; adenoma of the prostate; mixed tumors of the parotid gland, and the like.

OBVIOUS CONCLUSION

It is therefore evident why radium and x-rays are being employed more and more as synergists to surgery in dealing with these classes of cases.

In brief, educating patients with suspicious symptoms to report early to the surgeon for examination, in order that they may have the intelligent cooperative benefit of incisive, coagulative and radiologic surgery, offers the best and nearest approach to a complete treatment of cancer to-day.

Within our own memories, we have gone through the primary stage of hyper-enthusiasm over various cancer "cures," inspired by initial results obtained by caustics, by radical surgical operations, by x-rays, by radium, as well as by the various modalities which have been given the credit of curing those tumors transplanted into the lower animals which we now know spontaneously cure themselves if let alone. We offer no apology for the hopes primarily inspired by the truly marvelous results obtained by the surgical and radiological methods. Longer observation, however, tempered our enthusiasm, and prompted by disappointments, we entered the second stage or that of disillusionment and even scepticism. But even in the depths of our scepticism we could not deny that we had ameliorated the symptoms of cancer by diminishing the size of the tumors or even causing their disappearance; by controlling the pain, hemorrhage and discharge; by lessening cachexia; by fostering hope, and frequently even by rendering patients symptom-free for extended periods of time, and in some cases patients apparently developed cancer immunity; so eventually we have come to the middle ground of constructive conservatism, and believe that we are treating cancer more successfully to-day than ever before. In the light of cancer statistics it is no small achievement to render more comfort to these patients and to be able to improve these statistics even if we have not as yet found the specific cure.

During this development it has been interesting to observe the reaction of the medical mind to the adaptation of machinery and physical agents in the diagnosis and treatment of disease. This is well shown in the realm of diagnosis. For instance, it is freely admitted that even our best consultants are entitled to be occasionally mistaken in their diagnosis. The percentages of these errors based on clinical examinations seem to vary directly according to the number of autopsies that are performed. It is considered bad form to hold the clinician up to ridicule or criticism when these errors are discovered; but as soon as the diagnosis is based on x-ray findings there is immediately noticed a tendency to demand the same efficiency that we demand of machines—95 per cent or better, and when the roentgenologist is found in error, the only charity in criticism shown is that the criticsm is given freely. We notice the same thing in therapy by physical agents. For instance, while the physician who talks about curing heart disease, epilepsy, nephritis, tabes, or general paresis, is discredited, as soon as machinery or radium is used in cancer, statistics as to "cures" are immediately expected and demanded. I hope the time is not far distant when our position in cancer therapy will get the same recognition that any form of expectant treatment is according to-day, namely, that it is not perfect but that it affords the

best working hypothesis, and as such deserves encouragement until such time as someone can give us something better. If as cancer therapists we are to deserve it by giving our patients the most painstaking and scientific treatment that research has placed at our disposal.

We must understand how and when to administer the most heroic doses of radioactive energy with safety to the patient and without the procrastination that would interfere with surgical intervention. We must educate the surgeon so that he will welcome our cooperation. We must keep our skirts clear of any suspicion that we are trying to usurp any of the surgeon's well-earned prerogatives in this class of cases. We must show and maintain the superiority of good technique in administering massive doses of radioactivity and coagulation. We must expose the dangers and fallacies of believing:

1. That any x-ray machine capable of making good *x*-ray pictures is necessarily suitable for giving massive deep therapy.

2. That the possession of radium, no matter how small an amount, is a guarantee that the owner can ameliorate cancer in the most efficient way.

3. That any high frequency machine that can give a spark will do efficient diathermy.

We must be unanimous in showing that: (1) In order to give deep penetrating gamma rays, we must have an *x*-ray machine capable of backing up a 9 inch spark gap in air while the tube is in operation; we must have standardised our dosage by careful meter readings and checked up the skin action by pastille measurement; we must give the maximum filtered erythema dose compatible with safety, whether we choose to style that dose 3 B. Saboreaud-noire, 12 Hampson, 15 Holzknecht, 30 X Kienbock, or the maximum safe erythema dose; we must insist that the initial dose be the largest, because at the first treatment the tissues will stand a more heroic dose than they will later when endarteritis has obtained; we must cross-fire our rays; as it is well known that cancer is most commonly found where the reactions are acid, we must use every means of maintaining high alkalinescence, which includes attention to efficient sewage disposal and excretion throughout the system of each individual patient; if there is no skin over the neoplasms our dosages can be greatly increased as we no longer fear the tragedies of skin burns, and this may very properly lead to the consideration of the temporary surgical removal of the overlying skin in selected cases. (2) The minimum amount of radium element with which we can attack deep seated cancer is probably 50 mg.; more is better. The most efficient manner of applying this radium is in the needle form, whether the emanation or radium element is used. The initial dose should rarely be as small as 400 mg. hours; more commonly it should be 800 to 1200 mg. hours, and in selected cases and in experienced and cautious hands it may be as high as 1600-2000 mg. hours. It is assumed that such doses are properly filtered according to the results desired.

While the average surgeon was dilatory about mastering the intricacies of *x*-ray therapy and therefore its vogue has been limited, he lost no time in "climbing on the band wagon" of radioactivity when the more easily manipulated radium was exploited. This, together with the tremendous newspaper publicity as to the cost of radium, has materially simplified life for the roentgenologists (who also have radium). It is important, therefore, to recognize that with the exception of cavity work, practically all the results loudly acclaimed for radium were previously attained in less time and at less expense by skilled roentgenologists with *x*-rays. This fact seems to have been overlooked in most surgical clinics where radium has been adopted. It seems to me timely, therefore, to call attention to the relative merits of these two agents by the following table.

COMPARISONS OF RADIUM AND x-RAYS FOR THERAPY.

Radium.	*X-Rays.*
Has more penetrating rays in smaller volume.	Have less penetrating rays in greater volume.
Easier to handle.	Technique very exacting.
Applicators small in size.	Apparatus large and heavy.
Portable.	Practically non-portable.
No danger of high tension electrical shocks to patient.	Patients must be protected from high tension shocks.
Can be used in cavities.	Use in cavities has been abandoned.
Effects easily confined to small areas.	Larger areas can be treated.
Treatment takes more time—average treatment four hours per area.	Treatment takes less time—average treatment five minutes per area.
Costs more.	Costs less.
No deterioration, unless lost.	Constant deterioration, not only from wear and tear but also apparatus becomes out of date rapidly due to development of improvements.
Spontaneous generation.	Electrical and mechanical complications always to be contended with.

In conclusion let us all be untiring in our efforts to treat cancer in the *best way,* which consists of:

I. Education of the patients to come for examination early.

II. The maximum safe erythema dose of radium or x-rays on the day previous to the operation.

III. Radical operation.

IV. Postoperative prophylactic x-ray or radium treatments with careful technique.

MINNEAPOLIS

MINNEAPOLIS is a large, handsome, progressive city, with an invigorating climate and surroundings of unusual charm and interest. These features, with the added attractions of excellent railway service, good hotels and an open-hearted hospitality, have caused the "Flour City" of other days to be re-christened "The Convention City." Here, in the choicest season of the year—the early fall, with its cool, clear, bracing climate, and in a hotel which almost seems built for the purpose, THE AMERICAN ROENTGEN RAY SOCIETY will hold its Twenty-first Annual Meeting.

To the visitor Minneapolis offers every lure of the out-of-doors. It is the gateway to Minnesota's region of ten thousand lakes, plentifully stocked with fish of many varieties. Yachting, canoeing, motor boating, swimming, and fishing are to be enjoyed on waters within it own bounds, on properties controlled by the Park Board, within a few minutes' ride by automobile or street car from the center of the city.

One of the most fascinating of automobile drives follows along the miles of boulevard which wind around the string of five lakes lying within the city proper and through residential districts of great beauty. By night these boulevards are illuminated with ornamental lights which rim the lakes.

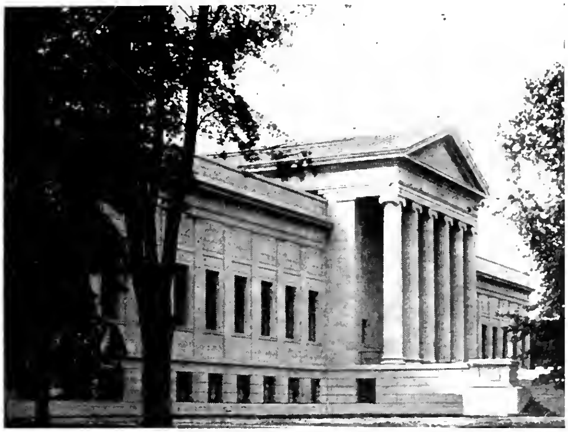
One-tenth of the entire area of the city of approximately fifty-three square miles is devoted to 110 public parks with a total of 4,000 acres and valued at $25,000,000. Minneapolis is one of the noted playgrounds of America.

THE GATEWAY, AT THE JUNCTION OF HENNEPIN AND NICOLET AVENUES

The falls of Minnehaha, immortalized in Longfellow's "Hiawatha," is included in a beautiful park of 142 acres. Near by is the Old Soldiers' Home, and a little farther on Fort Snelling, built in 1820, the refuge of the pioneers in the days of Indian warfare, and at present a modern U. S. Army Post. Attractive walks below the Falls lead to the Mississippi River; Winchell Trail from the Falls to the Lake Street bridge follow the course of old Indian trails. The Missis-

sippi's most attractive section is here where it flows through Minneapolis.

Within a short distance is Lake Minnetonka, the delight of tourists and fishermen. Many residents of Minneapolis own summer homes on its irregular shore line of more than 200 miles.



Minneapolis Institute of Arts

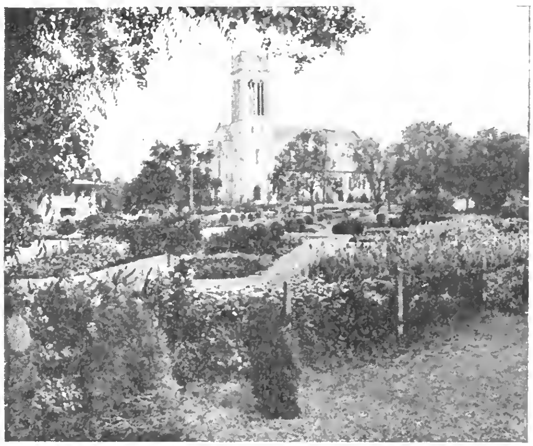
Artistic development has resulted from the influence of an unusual natural environment, and is emphasized and fostered by the Minneapolis Institute of Arts. The Walker private gallery of rare collections also is available to the public. The Symphony Orchestra which Minneapolis has developed, is one of the best organizations of its kind in America. The Institute of Arts is a public museum with a magnificent collection of paintings, and an exposition of the decorative arts including household furnishings of the thirteenth, fourteenth, fifteenth and sixteenth centuries. The Institute also displays attractive samples of the most beautiful silks produced in this country.

Minneapolis is the center of education in the Northwest. In addition to a number of excellent music, business and art schools in the city, it is the home of the University of Minnesota, one of the principal institutions of higher education in the United States. It occupies an area of 150 acres and has thirty large buildings devoted to various purposes. Its total enrollment exceeds 8,000 students.

The University is richly endowed and beautifully situated. On land directly opposite the city and sloping down to the waters of the Mississippi a campus has been planned by Cass Gilbert with a classic and orderly scheme of development which provides for a century's growth. Every school will have its own buildings, grouped around a hollow square or grassy quadrangle. The schools of medicine and engineering occupy the south end of the campus, and on high ground at the bend of the river stands the Elliott Memorial Hospital, the first medical building constructed under the Cass Gilbert plan. The college of medicine is one of the best departments of the University, and ranks high among the Class A schools of the country.

Besides the hospital, the medical department of the University has a nurses' training school and a dispensary. These elements of the school of medicine cooperate actively with the Minneapolis City Hospital, a large modern institution. There are many other hospitals in the city, self-supporting, or maintained in whole or in part by private charity or by religious societies.

A schedule of excursions is being prepared which will provide for every moment



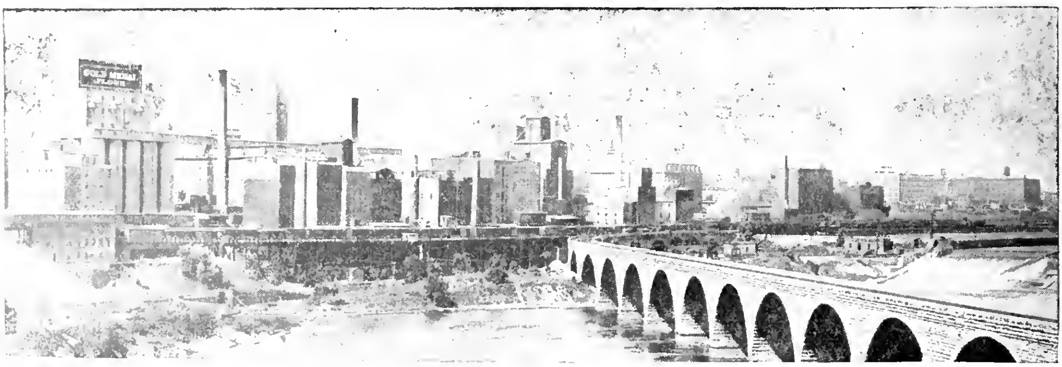
St. Mark's, One of the Most Beautiful of Minneapolis' Many Churches

that can be spared from the serious concerns of the meeting. It will include a visit to the University, a walk through the art museum and Walker galleries, a drive around the

"Chain of Lakes" within the city limits, another to Minnehaha Park, The Soldiers' Home and Fort Snelling; then the famous drive along the banks of the Mississippi to St. Paul—down one side and up the other; if there is time a few hours will be spent in going through one of the flour mills, the greatest in the world, where the process of grinding meal has come down unchanged in principle from the time of Joseph, the son of Jacob, in the land of Egypt. Last, but not least, a trip to Lake Minnetonka, with a dinner—but of that more anon.

Just a word about industrial Minneapolis, the wealth of production and sound business enterprise underlying the city's development. Minneapolis owes its existence to the presence of a cataract in the Mississippi River which was first utilized to turn the wheels of a small grist mill nearly seventy years ago by the garrison at Fort Snelling, the pioneer frontier army post. This experiment brought about the complete harnessing of St. Anthony Falls and resulted in the development which made Minneapolis the world's greatest manufacturer of flour. The daily ca-

One of the City's Two Main Thoroughfares, Nicolet and Hennepin Avenues. This is Nicolet.



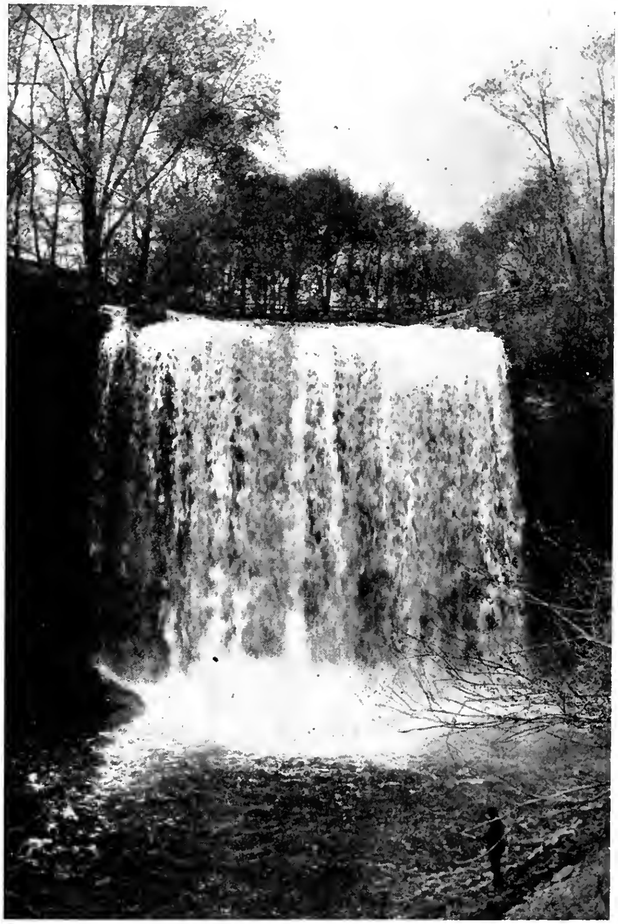
The Mississippi at St. Anthony Falls, with a Glimpse of the Milling District

pacity of its mills is 97,460 barrels, and flour shipments have exceeded 18,000,000 barrels annually. Industrial progress along other lines has given the city a wide variety of manufactures, and it ranks fourteenth among the industrial centers of America. Other merchandise produced by Minneapolis factories has found it easy to follow the trails blazed around the world by its first product, flour.

The energy of St. Anthony Falls was also devoted to the manufacture of lumber, and millions of logs from the great forests of northern Minnesota have been floated down the Mississippi and cut into lumber. While its sawmills have diminished rapidly within late years, Minneapolis is still the important lumber market and leading manufacturer of wood products in the Northwest.

The importance of its manufacturing and jobbing has made the city the principle market place and the financial center of the Ninth Federal Reserve District. Great financial institutions have been formed to finance its extensive trade, and to-day the city has sixty-six banks and trust companies. The bank transactions or turn-over for 1919 totalled $12,331,567,000.

"As one sees
the Minnehaha
Gleaming, glancing
through the
branches,

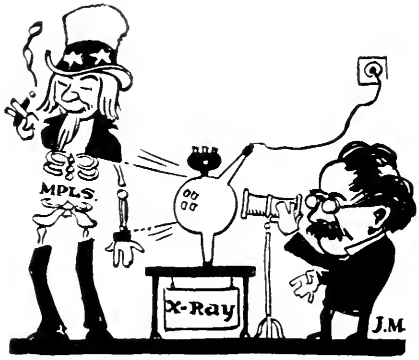


As one hears the
Laughing Water
From behind
its screen of
branches."

Minnehaha Falls

Backed by the resources of one of the most productive agricultural sections of the country, by proximity to the principal iron mining region of the world, and to vast areas of pine and other forests, and by its position at the head of navigation on the

Mississippi secured by the new government dam, the wharf recently erected by the city, and the newly projected barge lines which will connect it directly with South American ports, and by a carefully selected industrial site adequate for many years for new manufacturing enterprises, Minneapolis is assured of a continuous and substantial growth.



MINNEAPOLIS LOCALIZED

TRAVEL-DETAILS OF TRIP TO THE TWENTY-FIRST ANNUAL CONVENTION OF THE AMERICAN ROENTGEN RAY SOCIETY

Arrangements have been perfected with the Chicago Great Western Railroad for a special train from Chicago to Rochester. This train will leave Chicago at 6:30 P. M., September 13th, and arrive at Rochester at 6:30 A. M. the following morning, but you may remain in the cars until 8:00 A. M. if you desire. Our train will consist of sleeping cars, lounging car and dining car, serving a fine table d'hôte dinner at $1.50. We will spend the day in Rochester and leave there on the evening of September 14th by special train via the Chicago Great Western, arriving at Minneapolis the same evening in time to get located for the night at the Curtis Hotel.

Summer tourist fares are authorized to St. Paul and Minneapolis and other Minnesota points from nearly all territory, and it is suggested that those attending, travelling from or via Chicago or Kansas City, purchase this class of ticket, which will be honored via the Chicago Great Western through Rochester without additional charge. Furthermore, these tickets are good for stopover at any point, either going or returning.

For those who have the time, a nice way is to combine this Convention with their annual vacations or outings. The great Lake Park region of Minnesota is one of the famous summer vacation sections of the country. It is difficult to find elsewhere the happy combination of all the requirements for a delightful summer-land that exists in Minnesota. It appeals to all people alike, and has many things to attract the individual. Scenes change, as if by magic, to delight the visitor. The deer paths which Hiawatha was wont to tread, diverge from modern highways; lovely blue waters, lying still or glittering gemlike in some forest-ringed lake, become the winding stream chattering gaily through a rocky, turbulent course. Picture yourself at a comfortable resort or cottage at the end of the trail, with plenty of modern conveniences, a nice beach, alive and gay with the

laughter of frolicsome children and bathers; yet within ten minutes' walk or canoe ride, just around the first bend in the lake shore, you are in a wilderness of lake and forest, complete and sublime.

You can play golf on velvet forest glades, take fascinating canoe trips through tortuous channels and wilderness lakes, you can play tennis, ride horseback, swim, dance, rest —in fact you can do anything you want to do in Minnesota.

And—you can fish! There are some real bass, wall-eyed pike, great northern pike and muskellunge in Minnesota—ten thousand lakes full! They have all the "pep" you would expect of fish inhabiting clear cold spring-fed lakes and streams. You can find a good place to go almost anywhere in Minnesota, but perhaps you'd better ask our friend, Mr. A. C. Irons, General Passenger Agent of the Chicago Great Western, in Chicago, for one of his "Minnesota Lakes" folders, which will tell you very completely what you want to know.

Returning from Minneapolis, we can arrange for extra cars on the Great Western Limited, or if the number warrants, they will gladly operate a special train for our accommodation on a schedule that would be acceptable.

Reservations for sleeping car accommodations should be made through Mr. H. C. Hilbourne, General Agent Passenger Department, Chicago Great Western Railroad, 179 West Jackson Boulevard, Chicago.

All in the Day's Work

THE AMERICAN JOURNAL OF ROENTGENOLOGY

PUBLISHED BY PAUL B. HOEBER, NEW YORK CITY

Issued Monthly. Subscription, $6.00 per year. Advertising rates submitted on application. Editorial office, 480 Park Av., New York. Office of publication, 67-69 East 59th St., New York.

TWENTY-FIRST ANNUAL MEETING

The Twenty-first Annual Meeting of The American Roentgen Ray Society will be held at Rochester, Minn., and Minneapolis, Minn., September 14, 15, 16 and 17, 1920; at Rochester on the 14th, at Minneapolis on the 15th, 16th and 17th. Further details concerning the meeting will appear in these columns from month to month.

Meeting and exhibits will be held in the CURTIS HOTEL, Minneapolis, which can accommodate about 300 members and guests. Reservations should be made early.

OUTLINE OF PROGRAM FOR TWENTY-FIRST ANNUAL MEETING

The Twenty-first Annual Meeting of THE AMERICAN ROENTGEN RAY SOCIETY will be held at Rochester, Minnesota, and Minneapolis, from Tuesday to Friday, September 14 to 17, 1920, inclusive.

The first day of the meeting will be spent at the Mayo Clinics, which will furnish the entire program for the day. Dr. William J. Mayo has very kindly invited the Society, and has planned to concentrate for Tuesday, the 14th, such surgery as will be likely to be of interest both to roentgenologists and to physicians interested in radium. In other words, as far as possible such patients as have not been subjected to x-ray study will be gotten out of the way the day before or carried over until the day after the 14th, so that the entire major surgical effort of the day will be devoted to operations upon patients who have had roentgenological examinations, or where radiotherapy in the form of radium or x-ray is being used as an adjunct to surgery or in place of surgery. It is anticipated that there will be a skin clinic, a jaw and face clinic, and demonstrations by the Pathological, Urological, and Orthopedic Departments, in addition to the regular clinics, so that there will be no lack of clinical opportunity for every physician attending the meeting.

The Pullman cars in which the members arrive, both from the East and from the West, will be parked on the siding for the day, so that it will be unnecessary to remove luggage. After breakfast, the members and guests will attend the various clinics or demonstrations in which they are most interested; and after luncheon there will be a general program including an address by one of the Doctors Mayo. Towards evening the Society will go by special train to Minneapo-

lis, a three hour ride, where ample hotel arrangements have been completed.

The next three days of the meeting will be devoted to a general program, arrangements for which are being perfected. Any member of the Society who has not been approached regarding the presentation of a paper, and feels that he has something new or important to communicate, should address the President, Dr. James T. Case, Battle Creek, Michigan, at once.

Abundant entertainment is being provided for the ladies of the Society, including a banquet and dance for those who desire to participate. There will also be an evening of lantern slides.

One special feature of the meeting, coming near the close, will be the Caldwell Lecture, an innovation. This is an effort to introduce an annual lecture or an annual address delivered by some speaker of national or international repute, chosen by the President. The speaker will be given such time as he desires in order to present his subject adequately. The topic this year will be Gastrointestinal Peristalsis. The invitation to deliver this lecture has been accepted by Dr. Walter C. Alvarez, Instructor in Research Medicine in the George Williams Hooper Foundation for Medical Research, San Francisco, Calif. Dr. Alvarez is already well known to many of our readers and we shall be intensely interested in his presentation of the physiologist's view of gastrointestinal motor physiology. Every roentgenologist who undertakes diagnostic work in relation to internal medicine needs to know all he can regarding peristalsis of the digestive tube. The lecturer will bring our knowledge on this subject up to date and attempt to correlate it with the clinical aspects of gastrointestinal diseases.

The Scientific Exhibit is in the hands of the following committee: Drs. Frank S. Bissell, C. A. Donaldson and R. R. Knight, of Minneapolis. It is desired that all who wish to present an exhibit notify the committee in advance, so that ample racks may be provided. It is hoped that an extensive exhibit may be shown at this meeting.

Curtis Hotel, Minneapolis
Headquarters of the Twenty-First Annual Meeting.

WESTERN SECTION OF THE AMERICAN ROENTGEN RAY SOCIETY

FIRST ANNUAL MEETING

The first annual meeting of the Western Section of The American Roentgen Ray Society, will be held in conjunction with the Pacfiic Coast Roentgen Ray Society, at Avalon, Catalina Island, California, June 17, 18 and 19, 1920.

A program of unusual excellence is in course of preparation, adding to the usual high-class material of the Pacific Coast members, papers from roentgenologists of Washington, Oregon, Colorado, Utah and Montana. President Case, of The American Roentgen Ray Society, will be on the program, and other visitors from the East, who realize that no place short of Heaven is so attractive as Catalina Island in June, will be present and participate in the program and discussions.

W. W. Watkins,
Secretary.

CORRESPONDENCE

St. Louis, Mo.,
Sept. 10, 1919.

Dr. H. M. Imboden,
American Journal of Roentgenology,
New York City.

Dear Doctor Imboden:

There has come to my attention an article by P. L. Ansell, "The Roentgen Interpretation of Visceroptosia" in The American Journal of Roentgenology for September, 1919. In this article he quotes a classification of physical types into four groups, hypersthenic, sthenic, hyposthenic, and asthenic, giving Stiller credit for this classification. If Stiller ever originated or used any such classification it is entirely without my knowledge, and I am fairly familiar with Stiller's somewhat inaccessible writings. He did describe the condition which he called Asthenia Universalis Congenita.

The classification cited was originated by me, as was the description of the relation of bodily type to alimentary motility and tonus and the correlation of Schlessinger's classification of stomach forms to types of physique. I refer you to The American Journal of Roentgenology, April, 1917, *The Interstate Medical Journal,* Volume XXIII, No. 4, the Transactions of the American Gastro-Enterological Association for 1918 and Dr. F. M. Pottenger's "Clinical Tuberculosis," volume 1, pages 335 to 356.

I am at a loss to understand how such a mistake could have been made and I ask that it be corrected.

Very truly yours,
R. Walter Mills.

Oakland, Cal.
February 13, 1920.

Dr. H. M. Imboden,
480 Park Ave.,
New York, N. Y.

Dear Dr. Imboden:—

In my paper, "The Roentgen Study of Visceroptosia," published in the September issue of The American Journal of Roentgenology, an error was made as to the originator of the classification of Bodily Habitus; credit was given to Dr. Stiller instead of to Dr. R. Walter Mills of St. Louis, whose extensive research work and excellent contribution on this subject was the original contribution to medical science.

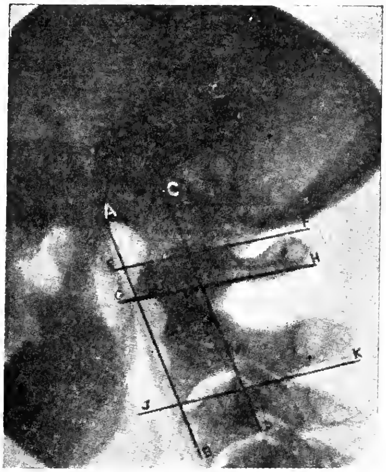
If you will kindly publish this letter in the next issue of the Journal and officially notify Dr. Mills to that effect, it will be greatly appreciated.

Sincerely yours,
P. L. Ansell.

TRANSLATIONS & ABSTRACTS

George, Arial W., M.D. A Method for More Accurate Study of Injuries to the Atlas and Axis. (*Boston M. & S. J.*, Vol. clxxxi, No. 13, pp. 395-398, September 25, 1919.)

The following study of injuries to the atlas and axis, and the didactic method used, is the result of instructing medical officers for *x*-ray service at the Medical Officers' Training Camp, Fort Riley, Kansas. The writer claims no special originality for the method. He commences the discussion of the subject by considering the normal roentgen anatomy of upper cervical region.



Normal Lateral View, Showing Lines Drawn to Illustrate Method

Lateral View. Before an interpretation can be made of the upper cervical region one must determine that the plate under examination has been taken in a true lateral position. This can best be determined by the position of the rami of the mandible. It is not possible exactly to superimpose the rami, though there should never be more than one centimeter's difference between the two. In the true lateral position, an imaginary vertical line can be drawn along the anterior surface of the bodies of the cervical vertebrae; also a similar line can be drawn along the posterior surface of the cervical bodies. While these lines will not hold good for the entire cervical region, for the purpose of diagnosis they are essentially true for the upper cervical region. In well developed male subjects, the anterior tubercle on the anterior arch of the atlas is frequently quite large and will project slightly anterior to the line drawn along the anterior cervical bodies. An imaginary line can also be drawn from the superior border of the anterior tubercle of the atlas to the superior border of the posterior tubercle. It will be approximately parallel to a similar line drawn from the inferior border of the anterior tubercle to the inferior border of the posterior tubercle. Within the rectangle formed by lines AB, CD, EF, and GH (see illustration), there is normally noted an increased density of bony structure. This is due to the fact that the lateral masses and transverse processes of the atlas, and the odontoid process of the axis are superimposed, and all lie within this area. The area within the parallel lines EF and GH, posterior to the rectangle above mentioned, comprises the posterior extremities of the lateral masses and the posterior arch of the atlas, including the posterior tubercle. The relation of the posterior tubercle to the base of the skull varies, rarely being more than one centimeter from the base of the skull except in congenital malformation. In a true lateral view, each side of the posterior arch of the atlas should appear superimposed. If both sides of the posterior arch can be directly seen, it is positive proof that the atlas was not taken in a true lateral position, and without other sufficient evidence, injury is not to be considered. The posterior part of the posterior arch appears to project slightly upward. This is due to the fact that the anterior part of this same arch is flattened from above downward, due to the groove for the vertebral artery. The posterior tubercle of the atlas is on a more anterior plane than the posterior extremity of the spinous process of the axis, but the anterior part of the posterior tubercle is never normally on a more anterior plane than the anterior part of the spinous process of the axis. This is due to the fact that the vertebral foramen of the atlas is larger than the corresponding foramen of the axis. The only apparent exception to this will be the congenital malformations of the atlas. The retro-pharyngeal structures form a vertical line parallel to the anterior aspect of the cervical bodies. The uniformly dark area anterior to this represents

the lumen of the pharynx. An imaginary line can be drawn from the lower border of the axis to the lower border of the spinous process of the same vertebra. It is approximately parallel to the line drawn from the lower border of the anterior tubercle of the atlas to the lower border of the posterior tubercle. In the rectangular space above the line JK, is the greatest part of the axis. The upper half of this area shows an increase in density of the bone due to the lower part of the lateral masses of the atlas, the superior articular processes, body, and part of the odontoid processes of the axis. The lower half of this rectangular space shows the body and transverse processes of the axis superimposed. The area posterior to the above rectangle, and between the lines GH and JK, contains the inferior articular processes, laminae and spinous process of the axis. Normally there is no break in continuity in the upper and lower borders of the laminae of the axis. The anterior portion of the spinous process of the axis is always on a more anterior plane than the anterior part of the posterior tubercle of the atlas.

Antero-Posterior View. In an antero-posterior view of the upper cervical reion, imaginary vertical lines can be drawn from the lateral and median margins of the lateral masses of the atlas, passing through the lateral and medial margins of the superior articular processes of the axis, and are approximately equally distant apart. The odontoid process appears in the central portion of the two median lines. The hyaline cartilage on the inferior articular surface of the lateral mass of the atlas and the superior articular surface of the axis is of uniform thickness on each side, thus resulting in an apparent clear space on each side, since they offer no obstruction to the roentgen ray. The posterior arch can be recognized by a continuation of the shadow of the arch with the transverse processes, and as it is in closer proximation to the plate than the anterior arch, it is more clearly seen on the plate. The anterior arch may be occasionally recognized, and can be demonstrated by its conjunction with the spongy bone comprising the lateral masses. In the average case the apex of the odontoid processes projects just above the shadows produced by the arches. From the roentgen standpoint, the superior articular surfaces of the axis are more or less flattened, or even slightly concave, and the inferior articular surfaces of the atlas are slightly concave. The body of the axis is of uniform density and structure, excepting in the median line, where we can sometimes see the shadow of the bifid spinous process of this vertebra.

PATHOLOGIC ROENTGEN ANATOMY OF UPPER CERVICAL REGION

Lateral View. One of the most important observations that can be made of the pathology of the osseous system is the loss of the normal curves by the formation of acute angles. Injuries, destructive bone diseases, etc., will be early recognized by the formation of these angles; this is particularly true of the vertebral column. In the interpretation of injuries and diseases, the value of the imaginary lines as mentioned above becomes of utmost importance. Dislocation, without fracture of the atlas, will always obliterate the normal articular space between the inferior articular surface of the lateral mass of the atlas and the superior articular process on the side of the dislocation, or both sides. There is no possible position in which the normal head can be placed to obliterate the normal articular space mentioned above.

CONGENITAL MALFORMATIONS OF UPPER CERVICAL REGION

The most important congenital malformation in the upper cervical vertebrae from the roentgen viewpoint is that of the posterior arch of the atlas. Comparatively frequently a bony spiculum is seen which arches backward from the posterior extremity of the superior articular processes of the atlas to the posterior arch, converting the vertebral groove into a foramen, through which the vertebral artery passes. This foramen should not be confused with an area due to destructive bone pathology.

ROENTGEN TECHNIC OF UPPER CERVICAL REGION

Lateral View. The patient is placed in the prone position with the head resting on the table, the face being directed upward, parallel to the table. In this position a line perpendicular to the table can be drawn from the lower border of the upper incisor teeth to the tip of the mastoid process. If a lateral view of the entire cervical region is desired, the shoulders

are forced downward as far as possible and a plate is placed on the lateral side of the neck, pressing down on the shoulder. The plate is held in position by a head-rest, sand bags, etc. The tube is tilted on its side, a small diaphragm, together with a small cone, being used. The central ray is centered immediately posterior to the ramus of the mandible. Another position which will give the same results is obtained by having the patient sit in a chair with the tube tilted on its side. The plate is held by an assistant against the neck.

Antero-Posterior View. In the ordinary antero-posterior view of the cervical region the upper two or three cervical vertebrae will not be seen, on account of the location of the mandible anterior to these vertebrae. In order to obtain an antero-posterior view of the atlas and axis it is necessary to place the patient on the table in a manner similar to that necessary for a lateral view, viz., prone position with head on table, face directed upward, parallel to table. The mouth is opened to its greatest extent, a cork being placed between the teeth to maintain this position, and a plate is placed well up under the occiput. A small diaphragm, together with a small cone, is used, the central ray being centered over the center of the open mouth.

W. W. Belden.

Knox, R., and Kaye, G. W. C. The Examination of Air Craft Timber by *X*-Rays. (*Trans. of the Faraday Soc.*, Vol. xv, Part 1.)

It was found that all woods are very transparent to *x*-rays, and soft tubes were necessary, the alternative spark gap being usually from 1–2 inches between point electrodes. The chief defects to be looked for were spiral grain, large hidden knots, resin pockets, compression shakes, incipient decay, dote, grub holes. No difficulty is found in seeing all these, and excess or deficiency of glue in glued joints is easily revealed. Every detail in workmanship is clear, and in most cases a fluorescent screen examination is enough. Ordinary visual inspection does not show a badly-fitting strengthening block or wood split by screws. "A concealed mistake may cost a brave man his life" was the printed injunction in the works. It was interesting to see at a recent scientific exhibition the flaws in splendid pieces of timber, long cracks, holes, decay, all spoiling the nicety of adjustment and endangering life.

Ordway, Thomas, Tait, Jean, and Knudson, Arthur. Metabolism in Leukemia and Cancer during Radium Treatment. (*Albany M. Ann.*, Jan., 1920.)

In a study concerning the "constitutional reactions" which in certain cases followed the application of radium, the authors found them particularly marked in cancer with suppuration, such as carcinoma of the cervix, and where lukemia had undergone prolonged radiation. It seemed evident that changes in the nitrogenous metabolism depended on the amount and nature of tissue autolysis. In two cases the phosphates showed an extraordinary increase due to the nature of the tissue autolyzed. In a case of breast carcinoma the lesion was of hard, brawny, fibrous tissue, in which little or no autolysis would be expected. There was practically no increase in the products of nitrogenous metabolism, and only moderate increase in the total acidity of the urine. It would seem that the changes in the urine as a result of radiation are due, partly, to products derived from autolysis of the abnormal tissue under the influence of the radiation from radium. Only one of three cases quoted showed any systemic reaction because of radiation and, here, the nitrogenous substances in the urine did not show as excessive increase as in the cases of leukemia showing no general symptoms of toxemia.

Bainbridge, Commander William Seaman, M.C., U. S. Navy, R.F. A Study of Certain Bands in the Right Upper Abdominal Quadrant.Illustrated by Cases. (*Med. Rec.*, Vol. 97, No. 15.)

The object of this paper is twofold: First, to draw attention to some points which have proved of practical value to the writer when operating upon the abdominal viscera. Second, to report, in brief, some selected illustrative cases.

1. The prone position often fails to give the surgeon an exact conception of the conditions present when the abdomen is opened. Early bands and adhesions are often overlooked or their importance not realized. The reverse Trendelenburg will be of aid in arriving at an

exact diagnosis. However, this frequently is not sufficient. We must put traction downward on the hollow organs, so as to picture what would be the relations if the erect posture were assumed.

2. It was only after the anatomist placed the body erect, froze it in that position, and made sections, that the exact anatomy of the body cavities and their organs was determined. The roentgenologist early realized that much could be learned by the examination in the upright position. Would not a few dissections made by the abdominal surgeon, with the body upright, be of great value in preparing him for his work? I have found it so myself.

3. Many a small band or adhesion when seen in time, and its significance understood, will, if treated adequately, prevent more serious conditions.

4. "Breaking up of adhesions" is an unfortunate term. In very bad cases that may be all one can do—literally tear these bands and hope that chance will bring those which inevitably reform in places where they will not do as much harm as before. Success sometimes follows such a course, but more often failure. By carefully dividing bands transversely and suturing longitudinally, by flaps of peritoneum or of omentum or skin grafts, many a case of distressing adhesions can be cured.

5. Early adequate attention to bands and adhesions in the right upper abdominal quadrant often makes such operations as cholecystotomy, cholecystectomy, and gastroenterostomy unnecessary.

6. May it not be possible that by a just estimate of the mechanism of the abdomen and careful attention to the lessons learned, we may better order our lives from the beginning and so often prevent the formation of bands and adhesions, thus obviating their serious sequellae?

THOMPSON, HAROLD B. Osteomyelitis and Its Classification Radiographically. (*Northwest Med.*, December, 1919.)

Dr. Thompson says that the ordinary classification of the disease differs considerably from one from a radiographic standpoint, and that the latter is necessary if the radiologist is really to help the surgeon. Osteomyelitis can be best classified radiographically as to its origin, medullary, cortical or periosteal. The medullary type corresponds to the idiopathic acute osteomyelitis in the old classification, and operation should not be stayed while waiting for an x-ray plate. The cortical corresponds to the chronic form of the old classification, due to some low grade infection, usually following an injury. This tends to remain localized; there is less destruction of, and more production of bone. The periosteal type can only be diagnosed radiographically after some weeks, when it usually affects the cortex secondarily. There is more bone production than destruction, and it usually follows an injury.

PANCOAST, HENRY K. Roentgen Ray Studies of the Functional Alterations of the Diaphragm. (*N. York M. J.*, 28 Feb., 1920.)

Dr. Pancoast urges the study, radioscopically, of the diaphragm as an important aid to diagnosis. The special conditions necessitating it are: Paralysis of the phrenic nerve as a result of systemic poisoning, injuries or disease of the cervical spine, tumors, abscesses or direct injury in wounds; inelasticity of the lungs, such as caused by fibrosis, the end result of tuberculosis, abscess, gumma, etc.; diseased conditions of the pleura acting by pressure, adhesions; obstruction in air passages from foreign bodies; reflex disturbances, principally pain, *i.e.* in pleurisy, where the diaphragm on the affected side will be found motionless or nearly so; diaphragmatic hernia and eventration; conditions below the diaphragm, such as subphrenic abscess or perinephric abscess. In ascites with much fluid, the diaphragm is greatly elevated and restricted in movement. The use of the rontgenoscope is a perfectly safe procedure and requires only a few seconds.

CROUSE, HUGH. Chronic Duodenal Dilatation, Its Concomitant and Sequential Pathology. (*Texas State J. M.*, Vol. xv, No. 11, March, 1920.)

Chronic duodenal dilatation is a frequent instead of a rare, pathological condition. If the above statement be true, it is extremely important that this changed bowel condition should be recognized, in order that its concomitant and sequential pathology may be dealt with as an accompanying state or pathological sequence, instead of as a single, or primordial

condition. The adult human duodenum has many developmental faults to contend with. The major portion of the etiology, in a pathological sense, would be removed if this type could retain its early embryological state of no angulation, rather long mesentery, and consequential fairly free movements, also freedom from being compressed between the body of one of the lumbar vertebra, abdominal aorta and inferior vena cava, by the passage of the superior mesenteric artery over its last third. Histological, physiological and anatomical comparative studies show the human animal paying a digestive price for its higher special form, namely, the upright posture in locomotion. The first 12 inches of the small bowel varies markedly in its entirety from the remainder of the lesser gut. Histologically, it contains all of the mucous membrane structures of the remainder of the small bowel, namely, villi, glands of Lieberkuhn, and mucus-secreting pavement cells, yet, in addition to these, beneath its muco-muscular layer, there exists a chain of isolated racemose bifurcating tubular glands, classified as the glands of Brunner. These last listed secretory structures extend only slightly beyond the duodenal jejunal angle, so they must be classified as strictly duedenal features. Diverticulum of the duodenum, another obstructing factor, is not uncommon. Many interpreted duodenal ulcer appearing skiagraphs are but this pathologic gut eversion. Troubles of the head of the pancreas, such as cysts, hematomas, malignant growths and hypertrophied interstitial conditions of this gland impinge upon and compress the first and second third of the duodenum. Exaggerated stimulation of the nerve supply of this portion of the gut at times occurs, as the result of reflexes from lower located pathological states, and induce a clonic-like muscular band action on the part of the circular muscular fibres of the bowel. Boothby has demonstrated the so-called Oschner bands to be but the above, or simple thickenings of the muscular coat, not constant, as the latter thought, but only now and then occurring, here and there, placed within the second and third portions of the duodenum. A straight-dropping jejunum, instead of a normal sweep into the left renal fossae, and in consequence an increase of the normal angle of the duodenal jejunal juncture, completes the pathological sauce of duodenal obstructions. The symtomatology is that of a right epigastric distress, at first irregularly occurring, nearly always three to four hours after a meal; finally constant, varying only in its degree of severity, belching, marked auto-intoxication, accompanied by constipation, an irritable, rapid or irregular heart, the latter not explainable from a cardiac fault or exophthalmic goitre conditions, neurasthenia, headache of a hemicranial type, scanty, high specific gravity urine, not always indican laden. The diagnosis of a chronic duodenal dilatation is based upon the clinical history giving the above symptoms, careful *x*-ray findings, serially taken ten to twenty minutes apart for one hour, then a six-hour skiagraph, as for stomach motor inadequacy, pictures taken in the upright posture, using Quimby's suggestion of the dragging of the stomach up and to the left, by the patient utilizing the left hand.

A study of this subject, not alone through personal observation but careful review of the literature, leads him to the following conclusions:

(1) That there is in all probability a chronic, pre-existing duodenal dilatation in all acute gastro-duodenal dilatation cases, and that the duodenum should be inspected, or at least palpated, teh same as the gall bladder or appendix, in all abdominal operations, where such palpation does not disseminate a distant infection.

(2) All gall-bladder, gastric and colonic operations are not complete without the inspection of the first third, the lifting up of the transverse colon and investigation of the retrocolonic placed duodenum, as well as the duodeno-jejunal fold.

(3) That duodenal dilatation is a frequent, not a rare condition.

(4) That its cure is through the medium of surgical intervention.

(5) That duodeno-jajunostomy will cure the major portion of duodenal ulcer cases.

(6) That many gastric ulcer cases treated by the posterior No-loop, gastro-enterostomy technique, should also have a duodeno-jejunostomy performed.

Elding. Ein sehr seltener Fall gutartigen Lungentumors (A Case of Non-Malignant Tumor of the Lungs). (*Fortschr. a. d. Geb. d. Röntgenstrahlen,* 1917-18, Vol. 25, 25.)

In the left lung of a woman, who presented no pulmonary but merely nervous symptoms,

an oval shadow was found accidentally under the x-rays which was thought to be either a hydatid cyst or a non-malignant growth, from the sharp outline and from its being surrounded by normal lung tissue. The mass was the size of a tangerine orange, and grew somewhat between the first and second x-ray examination. After much consideration the patient was subjected to operation, and the mass was removed successfully. Recovery was uneventful. It proved to be a non-malignant tumor largely composed of cartilage, but also containing fatty tissue, connective tissue, unstriped muscle fibers, and collections of lympocytes. The whole tumor was covered with a simple epithelial layer of non-ciliated cubico-cylindrical cells. The shape and sharp limitation of the shadow (along with the absence of change in the surrounding tissue) argued against an infective process such as gumma. Nor was there reason to suspect a secondary malignant mass, while the same characters of the shadow eliminated mediastinal growth or enlarged tuberculous glands.

W. S. L.-B.

Japiot. Fracture du scaphoïde sans déplacement décelée par la radiographie (Fracture of Scaphoid without Displacement, Shown Radiographically). (*Progrès méd.*, 1919, 378. [Abstracted from *Archiv. d'électr. méd.*, 1919, Vol. 27, 54.])

On a wounded man presenting simply the clinical signs of a fracture of the styloid process of the radius (following on a fall on to the hand), radiography revealed, besides the foreseen lesion, a fracture of the scaphoid, Y-shaped and without displacement. A frontal radiograph alone was not sufficient for this diagnosis; proof by a side-view was necessary. With the wrist lying with the radial side downwards on the plate, the shadow of the scaphoid was thrown by turning the back of the wrist toward the plate. The author insists on the rarity of the combination, viz., fracture of the scaphoid and of the styloid process of the radius. He mentions besides, the necessity for methodical examinations, the utility of comparative radiographs, and the advantages of variations in the position of the member to be examined.

W. S. L.-B.

Schwarz. Uber Kontrastmehlkonkremente in Dickdarm - Röntgenuntersuchtungen (Contrast-meal Calculi after X-ray Investigation of the Large Intestine). (*Therap. Monats.*, 1918, Vol. 32, 9. [Abstracted from *Zentralbl. f. Chir.*, 1919, Vol. 46, 255.])

The author refers to the possibility of the formation of a fecal calculus from the contrast-meal taken for the purpose of X-ray investigation. In one case this caused a moveable, painful tumor in the right lower abdominal region, for which appendectomy was performed. He also refers to the literature, which shows that the wall of the cecum changed by disease is easily affected by coprostasis, and urges that, after a contrast-meal has been given, increased evacuation of the bowels is necessary.

W. S. L.-B.

THE AMERICAN JOURNAL OF ROENTGENOLOGY

Editor, H. M. Imboden, M.D., New York

VOL. VII (NEW SERIES) JULY, 1920 No. 7

THE USE OF BURIED EMANATION IN THE TREATMENT OF MALIGNANT TUMORS*

By HENRY H. JANEWAY, M.D.

Attending Surgeon to the Memorial Hospital and Chief of its Radium Department

NEW YORK CITY

At the last meeting of this society, nearly a year ago in Atlantic City, I presented a paper (recently published in The American Journal of Roentgenology) on the advantages of buried emanation in the treatment of many types of cancer, with a report of illustrative cases. A year's additional experience has better defined the indications for burying emanation, has more accurately standardized the dosage, and has enhanced the value of the results by increasing the duration of the post-therapeutic period in many patients. Our conclusions upon the advantages of this method have been confirmed.

INDICATIONS FOR THE USE OF BURIED EMANATION

Mouth. It should be used:

(1) In combination with surface treatment in cancers of the lip when there is deep infiltration of the substance of the lip.

(2) In cancers of the interior of the mouth not limited to the alveolar processes, with the exception of the superior alveolar process in those originating in or involving by direct extension the maxillary sinus.

(3) In practically all carcinomas of the tongue and floor of the mouth.

(4) In cancer of the tonsil and adjacent structures.

Rectum. (1) As a reinforcement to the treatment by tubes in annular growths, and (2) alone in growths limited to one segment of the rectal wall.

Cervix Uteri. In carcinoma of the cervix, buried emanation is reinforced by the chain of tubes placed in the utero-cervical canal. The words "reinforced by" express the fact exactly, since in cervical carcinoma buried emanation is the most important part of the treatment.

Prostate and Bladder. The emanation tubes are buried in the prostate through the perineum, or when accuracy requires, may be introduced safely through the anterior wall of the rectum.

Breast. Buried emanation may be used in non-ulcerated carcinomas of the breast when it is desired to avoid surgical removal.

Lymphatic Glands. In primary or metastatic tumors of the lymphatic glands which form spherical masses, more especially those adherent to surrounding tissue but not in too intimate relation to important nerve trunks.

Sarcoma. Bulky spherical or fusiform sarcomas of the extremities may be treated with buried emanation.

*Read by title at the Fifth Annual Meeting of The American Radium Society, New Orleans, La., April 26, 1920.

The chief advantages of embedded emanation for the growths of the mucous membranes above mentioned are the accuracy of the primary application, the economy in the use of radium, and the ease with which residual incompletely treated remnants of the tumor left after the initial treatment may be destroyed by embedding emanations in these remnants as soon as they are identified. Often one such supplementary treatment of the tumor process is sufficient to dispose of a growth from which otherwise a fatal recurrence would take place. The most important detail in the successful treatment of these growths is the correct interpretation of the changes in the post-therapeutic period.

Dosage. It is difficult to formulate rules for dosage, and such rules are always subject to modifications imposed by the special conditions present in any case.

The volume of the tumor is the most important factor in determining the dose, but the shape of the growth is of almost equal importance, and influences the dosage hand in hand with the volume. An elongated superficial growth will, for instance, require almost the same dose as a circular superficial growth with a diameter equalling little less than the long axis of the elongated tumor.

A flattened tumor with little deep infiltration requires approximately the same dose as a spherical tumor with a diameter equalling the long diameter of the flattened growth. Between these variously shaped tumors there is a great difference in cubical volume, but the difference in the number of milli-curies required by them is not proportional to this difference but rather to the difference in the number of square centimeters in the plane of the tumor's largest diameter.

For these reasons the diameters of tumors are the most practical guides to the doses required by them.

The following table illustrates approximately the dosage of buried emanation which we are using at the Memorial Hospital for epidermoid carcinoma, many spherical breast tumors, and sarcomas.

In using the dosage of this table it must be remembered that an important difference exists in the radiation which the tissues receive when exposed for equal periods to embedded emanations and radium elements, the former in undergoing continuous decay and

FOR CIRCULAR AND APPROXIMATELY OVAL TUMORS OF THE SAME LONG DIAMETER:

Diameter	*Deep Infiltration*	*Surface Area*	*Dosage*
1 cm.		.77 sq. cm.	5 mc.
1½ cm.		1.7 sq. cm.	8 mc.
2 cm.		3.14 sq. cm.	10 mc.
2½ cm.	Not more than 1½ cm.	4.8 sq. cm.	15 mc.
3 cm.	Between 1 and 2 cm.	6.5 sq. cm.	17.5 mc.
4 cm.	Between 1 and 2 cm.	12.5 sq. cm.	20. mc.
5 cm.	Between 1 and 2½ cm.	19.3 sq. cm.	22.5 mc.
6 cm.	Between 1 and 3 cm.	28.27 sq. cm.	25 mc.

For spherical tumors there is little difference:

Diameter	*Area of plane of diameter*	*Number cubic cm.*	*Dosage*
1 cm.	.77 sq. cm.	.52 cb. cm.	5 mc.
1½ cm.	7.7 sq. cm.	1.70 cb. cm.	8 mc.
2 cm.	3.14 sq. cm.	4.18 cb. cm.	10 mc.
2½ cm.	7.8 sq. cm.	8.19 cb. cm.	15 mc.
3 cm.	6.5 sq. cm.	14.08 cb. cm.	20 mc.
4 cm.	12.5 sq. cm.	33.44 cb. cm.	22 mc.
5 cm.	10.3 sq. cm.	65.29 cb. cm.	25 mc.
6 cm.	28.27 sq. cm.	112.86 cb. cm.	30 mc.
7 cm.	38.48 sq. cm.	180.03 cb. cm.	35 mc.
8 cm.	50.26 sq. cm.	251.52 cb. cm.	40 mc.

the latter remaining of constant strength.

Results. In considering the results, a brief note will first be made on the fate of the eleven cases reported at length last year. Of these eleven, two have died—one, a man of seventy-three, in whom a complete retrogression of an advanced carcinoma of the tongue was obtained, died of diabetes. Up to the time of death there was no demonstrable recurrence of his carcinoma. The other, a man of sixty, with very advanced carcinoma of the nasopharynx with bilateral cervical metastases, in whom great retrogression and relief had been obtained, developed a local recurrence in the left nasal cavity, and later a small enlargement of freshly involved cervical lymph nodes. Ten days before his death the recurrence in the nose seemed under fair control. The remaining nine patients are still well and free from evidence of malignancy, and another year can be added to their post-therapeutic course.

To these cases many additional ones of similar character have been added during the past year, which will be published in detail later.

A TRAVELLING FOREIGN BODY

By E. C. KOENIG, M.D.

Buffalo General Hospital

BUFFALO, N. Y.

THIS is the case of a child who accidentally swallowed a pin which lodged in the upper part of the esophagus. The position of the pin was located, the child taken to the hospital and anesthetized, but no pin was to be found with the esophagoscope. *X*-ray again located the pin, this time in the

right bronchus. The surgeon debated that night whether or not to remove the pin from the bronchus and decided to wait until morning. In the morning the child was perfectly comfortable with no distress. I made another plate the following day and found that the pin was no longer in the chest. From the position on the plate I considered it must have been outside the stomach, and found it down in the region of the cecum. The child had coughed the pin up and swallowed it and within forty-eight hours he passed it through his normal channels.

We have then in this case a child, first, with a pin lodged in the upper part of his esophagus; the pin becoming dislodged, slipped by the epiglottis, through the larynx and down the trachea to the right bronchus. Later the pin was coughed up, swallowed, transmitted along the alimentary tract and finally expelled from the rectum.

THE TREATMENT OF RECURRENCES AND METASTASES FROM CARCINOMA OF THE BREAST BY MEANS OF RADIUM AND ROENTGEN RAYS*

By GEORGE E. PFAHLER, M.D.

PHILADELPHIA, PA.

BOTH radium and the roentgen rays have proven themselves of undoubted value in the treatment of malignant disease. Every physician who has mastered a good technique, who has used skill and good judgment in the treatment of malignant disease, has seen some brilliant results produced by either agent. He has also seen many failures by either agent, and in some instances failure has taken place in cases in which success seemed certain. Therefore, it is much better if we learn to combine these agents and use one to reinforce the other so that we may affect more patients favorably than is possible by either agent used alone. Undoubtedly more patients recover from malignant disease to-day than ever before, while many others that are hopeless are made more comfortable and their lives are prolonged. Still we must admit that malignant disease is on the increase, and therefore it is clearly our duty as physicians to utilize every means at our command to combat it. With the many agencies and brilliant minds now at work in searching for the cause of malignant disease, we may sooner or later find it. While the true cause of malignant disease has not yet been determined, we do know that many pre-cancerous conditions, such as warts, moles, chronic fissures, chronic ulcerations, and benign tumor formations ultimately become malignant, and we also know that in the non-malignant stage all these conditions can be cured, many of them by destruction by means of electro-coagulation, carbon dioxide snow, excision, or by the local application of radium or the roentgen rays; and if all such lesions are treated early, and if every physician and patient is on the alert to eliminate the so-called simple conditions, we shall have made great steps in advance in the treatment of malignant disease.

One of the most discouraging experiences that every physician has is the discovery of a recurrence or metastatic nodule following amputation of the breast for carcinoma. Recurrences and metastases may develop early after the operation, but generally it is after several months, and even as long as eighteen years after the patient has considered herself perfectly well. Many of these recurrent nodules and metastases are in locations where they cannot be practically removed by surgical means. In fact, I question the advisability of an attempt at removal, for if the original operation, which was clean and done at a time when operation was much more favorable, failed in that stage, how can we hope for success in these later stages? Therefore, we must acknowledge that when these recurrences and metastases develop, our only real hope for their control is by means of radiation. The two agents at our command are radium and the roentgen rays. The greatest amount of skill and thoroughness is necessary if success is to be obtained, and in many instances failure will result even then.

The Place for Radium in Malignant Disease of the Breast.—It has been my observation from the use of these two agents, that radium will produce a greater local effect in proportion to the amount of surface irritation as compared with the roentgen rays. I have also noticed that radium will produce a more pronounced effect upon localized nodules than the roentgen rays, but that the roentgen rays are more useful for their general and wider distribution and for the treatment of deeper lesions, which can be reached

* Read at the Fifth Annual Meeting of The American Radium Society, New Orleans, La., April 26, 1920.

by skillful cross-firing effect. Therefore, in the treatment of localized nodules in line with the incision, or of those localized in the axilla or in the supraclavicular region, I make use of radium because the radium can be brought into immediate contact with these nodules, and they can be made to soften and disappear. There is another distinct advantage in the treatment of the nodules located in the axilla by means of radium, because one can place it deep into the axilla much more conveniently than the roentgen rays can be applied. I have seen nodules the size of my thumb disappear within a month from the beginning of the application of radium. The radium must be applied with skill and due consideration must be given to the amount of radium, the amount of filtration, the distance from the parts to be affected, and the time of the treatment. I believe it has not yet been proven whether massive dose treatment by radium or fractional doses will prove the most desirable, but it is the general impression that the massive dose treatment would produce the most satisfactory results and can be applied with more skill. A report on any particular case in which radium has been applied and in which only the amount of radium is mentioned, or even the duration of application, means little or nothing, for we know very well that the effect varies with the square of the distance at which it is applied, and that the effect is modified very much by the amount of filtration. Variations in the application must be made according to the conditions in any given case, and these patients can no more be treated by rule than pneumonia patients or appendicitis can be treated by any fixed operation.

In each instance one must consider the rate of growth, the number of nodules, the general tendency towards recurrence, and in every instance a careful roentgen examination of the chest must be made, for it is my observation that about 50 per cent of the patients who come to me for postoperative treatment for carcinoma of the breast, have already mediastinal and pulmonary involvement. This high percentage of mediastinal involvement is likely due to the fact that in the majority of instances only advanced cases of carcinoma, which have been operated upon, are sent for postoperative treatment. It is my opinion that all cases should be sent for postoperative treatment, and I believe that a distinct advantage will be gained if anti-operative treatment is given by means of the roentgen rays. In a very general plan of treatment, which can at no time be followed blindly, for the treatment of these nodules, I would make use of radium filtered through ½ mm. of silver, 1 mm. of brass, 3 mm. of pure rubber and about 2 cm. of gauze or felt. The duration of the application will depend upon the amount and concentration of the radium used. In general, 100 mg. distributed over an area 4 x 8 cm., so as to produce as nearly as possible homogeneous rays, can be left in place twenty-four hours. Fifty milligrams can be left in place for twenty-four hours in the supraclavicular region. Fifty milligrams divided into two portions can be left in place in the axilla for twenty-four hours with like filtration.

Radium Effect. Within a week there will usually be some redness of the skin and within two weeks there is often desquamation of the surface of the skin. This always heals easily and at the end of two weeks there is usually a distinct reduction in the size of the nodule. If the nodules have appeared quickly, and are of short duration they disappear usually more rapidly. At the end of a month the redness of the skin will usually have disappeared, and if the nodule has not disappeared the treatment should be repeated. If they have disappeared I believe it is practical to wait two weeks longer and then repeat the treatment with the idea of getting rid of all of the local disease; or it may be well to give half a dose at the end of a month and another half dose two weeks later. I am not sure which of these procedures is best. In all instances, these recurrent nodules mean almost certainly that there are extensions of the disease elsewhere, and

these extensions may be in any direction, but are generally towards the mediastinum. Therefore, the greatest attention must be given to this distribution by means of the roentgen rays. In certain cases in which the nodules do not disappear completely or satisfactorily as a result of the surface application of radium as above described, a greater success can be obtained by means of the introduction of radium needles direct into the nodules and around about the nodules.

The Effects from the Use of the Roentgen Rays in the Treatment of Recurrence and Metastases. All of us have seen many recurrent and metastatic nodules disappear under roentgen radiation. Therefore, when radium is not at hand the roentgen rays should be used vigorously over the entire glandular and operative area, and in many instances complete and permanent disappearance of the nodules will take place. In other instances they will be reduced in size and will become isolated by fibrous encapsulation, and the patient's life will be considerably prolonged and rendered more comfortable; but in all instances, even when radium is at hand for direct application upon the recurrent nodules and metastases, the roentgen rays should be applied in all other areas likely to be involved. Therefore, the entire operative area and the entire glandular distribution from this area should be thoroughly treated by means of the roentgen rays with as much cross-firing as possible to the limit of toleration of the skin. The roentgen rays should especially be directed towards the mediastinum and pulmonary areas. More benefit may be derived from the treatment of the mediastinum by means of the roentgen rays than from radium, because we have an unlimited quantity of radiation at hand. We can place the source of the rays at a sufficient distance so that the difference between the skin and the deep effect will be minimized.

The advantages of the roentgen rays over radium for the general treatment of the chest following carcinoma of the breast are:

1. *Unlimited quantity of radiation.* The roentgen rays have less power of penetration than radium; but since the effects depend upon absorption this lesser penetration may not be a disadvantage. That the roentgen rays, even when produced by 50,000 volts, will penetrate all parts of the chest, is proven by every roentgenogram made of the chest; and when produced by 90,000 volts, such as is commonly used in deep roentgentherapy, we may expect certainly very much more thorough penetration.

2. *The roentgen rays can be comparatively easily distributed* over the entire operative field, including the lymphatic drainage from this area.

3. *The roentgen rays can be directed* into the mediastinum from many portals of entry, and in each instance the experienced roentgenologist can send these rays exactly into the diseased area. When necessary, the roentgen rays can be made to pass as accurately as a bullet or a knife in avoiding structures which are not to be rayed.

4. The source of the rays can be placed at *sufficient distance* from the skin so as to minimize the difference between the skin effect and the deep effect, which gives a great advantage over radium. I will illustrate the application of this principle as applied to the treatment of mediastinal disease and it will apply equally well in any deep-seated disease which must be reached by surface radiation.

The shortest distance to the mediastinum is through the sternum in an antero-posterior direction, and is approximately 2 cm. The deeper portions of the mediastinum in this same direction will be approximately 10 cm. from the surface. The distance from the lateral wall of the chest will be approximately 20 cm. from the axillary line in the average case. Therefore, in treating malignant disease in the mediastinum we must count on a skin-depth distance of from 2 to 20 cm.

In general *radium* is applied at a skin-surface distance of 2 cm. The intensity of radiation from a point decreases with the square of the distance. Therefore, at the

skin-surface the intensity will be $\frac{1}{2^2} = \frac{1}{4}$ or 25 per cent as compared with a distance of 1 cm. The intensity (ignoring absorption for the present) at a skin-depth distance of 2 cm. will be $(2 \text{ cm} + 2 \text{ cm.}) = \frac{1}{4^2} = \frac{1}{16}$ or .0625, or 25 per cent of the skin dose can be given at a depth of 2 cm. In other words, one would with radium be compelled to give 4 erythema doses over the sternum to get the effect of one erythema dose at a depth of 2 cm. This intensity of 25 per cent of the skin dose would only reach the nearest point of the diseased area in the mediastinum, and to reach the deeper portions of the disease in the mediastinum one would have to produce an effect at a skin-depth of 10 cm.

The intensity of radiation applied from a point-surface distance of 2 cm. to a skin depth distance of 10 cm. would equal $(2 \text{ cm.} + 10 \text{ cm.}) = \frac{1}{12^2} \text{ cm.} = \frac{1}{144}$. The intensity at 10 cm. skin-depth is therefore $\frac{1}{144}$ as compared with $\frac{1}{4}$ at the skin surface, or approximately 2.8 per cent of the skin dose. In other words, one would have to give approximately 36 erythema doses with radium at a distance of 2 cm. over the sternum to produce 1 erythema dose at a depth of 10 cm. in the mediastinum.

Let us now compare the corresponding roentgen ray technique. To affect the mediastinal tissues one would choose a focal-skin distance of 25 cm. The intensity of radiation at the skin as compared with 1 cm. would be $\frac{1}{25^2} = \frac{1}{625}$. The intensity at a skin depth of 2 cm. would be $(25 \text{ cm.} + 2 \text{ cm.} = 27 \text{ cm.}) = \frac{1}{27^2} = \frac{1}{729}$ of the intensity at 1 cm. We are of course limited by the skin effect or erythema dose, but when these intensities of $\frac{1}{729}$ at 2 cm. skin depth and $\frac{1}{625}$ at the skin are compared we find that approximately 86 per cent of roentgen rays reaching the surface will reach a depth of 2 cm. while only 25 per cent of the skin dose in the case of radium reaches 2 cm. in depth.

Now the intensity of the roentgen rays at a skin-depth distance of 10 cm. is $(25 \text{ cm.} + 10 \text{ cm}) = \frac{1}{35^2} = \frac{1}{1225}$. Therefore, $\frac{1}{1225}$ of the rays reach a depth of 10 cm. as compared with $\frac{1}{625}$ reaching the surface, or approximately 51 per cent. In the case of radium we found the intensity at 10 cm. skin-depth to be $\frac{1}{144}$ as compared with $\frac{1}{4}$ or approximately 2.8 per cent. Eighteen times as great a proportion of the skin dose from the roentgen rays reaches a depth of 10 cm. as compared with radium.

When treating through the axilla with the roentgen rays at a focal-skin distance of 25 cm. and a skin-depth distance of 20 cm. we get an intensity of $(25 + 20) = \frac{1}{45^2} = \frac{1}{2025}$ as compared with the skin intensity of $\frac{1}{625}$ or approximately 30 per cent. In the case of radium the intensity at the point-surface distance is $\frac{1}{4}$ and at the skin-depth distance of 20 cm. $(2 + 20) = 22^2 = \frac{1}{484}$, or approximately 8 per cent. Practically a negligible quantity of the radiation from radium applied in the axilla reaches the mediastinum, while 30 per cent of the roentgen rays reach this depth.

The second factor governing the amount of radiation reaching a deep point is the tissue absorption. According to Rutherford (quoted by Boggs and Viol, "Conditions for the Production of Deep Therapeutic Effects with Hard X-Rays and Gamma Rays." Read before the Eastern Section of THE AMERICAN ROENTGEN RAY SOCIETY, Jan. 29, 1920), the hard *x*-rays will be half absorbed in 4.9 cm. of tissue, and the gamma rays will be one-half absorbed in 26.5 cm. of

tissue. Therefore, approximately 75 per cent of the hard x-rays would be absorbed in the 10 cm. of tissue when applied through the sternum, and only 25 per cent (based on absorption) would reach the deepest point at a skin-depth of 10 cm., but since the law of intensity allows 51 per cent to reach this point we have as the actual amount reaching the deeper point considering both absorption and divergence 25 per cent of 51 per cent or 12¾ per cent of the total quantity reaching the surface. Therefore, if the x-rays are applied through eight portals of entry at a distance of 25 cm. directed toward a certain point 10 cm. deep, an erythema dose is produced at this deep point.

In the case of radium under the law of absorption approximately 7 per cent of the gamma rays will be absorbed in the 10 cm. of tissue, leaving on the basis of absorption approximately 93 per cent of the gamma rays to reach this depth; but on the basis of divergence of the gamma radiation only 2.8 per cent of the surface radiation reaches a point 10 cm. in depth. Therefore 93 per cent of 2.8 per cent = 2.6 per cent of the surface dose or the actual amount of gamma radiation reaches 10 cm. i ndepth as compared with 12¾ per cent of the surface dose in the case of the x-rays. In other words, by these calculations nearly 5 times as great a proportion of the surface radiation reaches 10 cm. in depth as in the case of radium.

In practical work one cannot get a cross-firing effect through eight portals of entry through the sternum; but the chest offers especial advantages for cross-firing from all directions, and since the distance is greater when treating through the lateral walls it is my practice to use all surfaces and divide them into a total of from eight to twenty portals. By this process I have produced definite results.

One of my best results is that obtained in a woman referred to me by the late Dr. Wm. L. Rodman, in 1911. He had removed one breast in 1910 for sarcoma, and the second breast in 1911 for carcinoma. She was referred to me for treatment of a mediastinal tumor as large as a man's fist. Under treatment this tumor reduced in size, the remainder partially calcified, and her general health to-day is good, permitting her to attend to her household duties nearly ten years after the removal of both breasts followed by mediastinal metastasis.

The ideal management of a case of carcinoma of the breast consists in a preliminary course of x-ray treatment covering the tumor and the lymphatics leading therefrom; then within a week, if circumstances permit, to remove the breast and all tumor tissue thoroughly. Postoperative x-ray treatment should then be given over the wound and the lymphatics in about four weeks from the anti-operative treatment. This should be repeated at intervals of a month or more for five or six times. If recurrent nodules develop in spite of this treatment, or in the absence of this postoperative x-ray treatment, then radium should be skillfully applied to such nodules, and the general areas and mediastinum should be thoroughly treated by the roentgen rays. Radium and the roentgen rays should never be applied through the same area of skin within a period of four weeks providing either has been used to the degree of an erythema dose.

CONCLUSIONS

1. Radium is our most useful agent in the treatment of palpable recurrent or metastatic nodules from carcinoma of the breast.

2. The roentgen rays is our most efficient agent in the general treatment of the carcinomatous area and the mediastinal and pulmonary disease.

3. Either or both agents must be applied with skill and with a knowledge of the principles which govern their action.

4. With skill and thorough radiation life can be prolonged, the patient can be made more comfortable, and in some instances the patient may be expected to recover.

DISCUSSION OF DRS. JANEWAY'S AND PFAHLER'S ARTICLES

Dr. R. E. Loucks, Detroit. In attempting to discuss the valuable papers of this symposium I am reminded of the old saying, "It is easier to be critical than correct"; but I want to offer a little word of warning.

Many scientific suggestions have been brought out that are based on physical and clinical experience. What I wish to emphasize particularly is the fact that we as medical men are apt to follow the other fellow and lose our individual observation of the case in view, and be content to do as he has outlined in some paper or clinic.

If you are content to take the path worn smooth by others who have preceded, you will always remain a follower without initiative. How often have we been content to treat a case according to some authority and be satisfied that the best has been done? I ask this question to arouse you to the fact that no two individuals are alike either in health or disease.

The old-time surgeon was content to remove the appendix for symptoms of appendicitis through a one-inch incision, while to-day the pathology is removed and he carefully scrutinizes all the organs of the abdomen and pelvis for any other condition that might cause the trouble or influence the recovery. So it should be with every one in any line of treatment. The best is only good when it comes to the treatment of the many human ills.

The great factors in therapeutic indications are the etiology of the disease, principle of immunity, treatment of the pathology and the close scrutiny of other underlying conditions that influence the recovery. Omit one and you commit the sin of omission.

Volumes are written on etiology and pathology. Immunity is still in the balance and swings from Ehrlich's to the hormone theory. Treatment is as varied as the four winds of heaven, but what I wish to dwell on are the underlying conditions that influence recovery.

Complications and sequelae may be more serious than the disease itself, as many of us have seen in the influenza epidemic. With malignancy under discussion we are attracted to the many complications that are confronted; whether it is malnutrition, anemia, toxemia, asthenia, obstruction or lack of resistance, they are all factors that hinder and prolong convalescence.

Why depend on a one-cylinder measure when a twin six will do it better, quicker and lighten the load? Lessen or abolish the complications and you will be surprised at the display of formative energy that is manifest in many of the bad cases.

Before closing I wish to emphasize the slogan of "Safety First" and remind you of the prophylactic issue that should always be foremost.

Dr. C. H. Viol, Pittsburgh. Since Dr. Pfahler has mentioned the paper of Dr. Boggs, and as I have worked with Dr. Boggs, I will discuss the paper for a minute or two. Dr. Pfahler probably saw a typed copy of Dr. Boggs's paper and we found after it had been sent that we had omitted a very important paragraph, and one which very radically changes the tenor of that paper, for you get the impression that there was a very wide divergence between radium and roentgen rays, and that is true if you consider your roentgen rays as a changing source which you can move off, and the radium one which you can move back only a few centimeters so as to even up the divergence effect. The paragraph which was omitted was discovered at the last moment, and was to the effect that if you make a distribution of your radium you very considerably cut down the effect on the surface and so very greatly enhance the effect below the skin surface. If you arrange the radium in a distribution over the surface, getting a plaque effect, you can get about the same effect as with the roentgen tube back to 25 cm. If the radium is considered as just a point source, then it would be almost a clinical impossibility to produce anything like favorable results in the treatment of mediastinal tumors, and I believe there are reports of quite favorable results in the treatment of these tumors where only radium was used. I am sorry the omission of the paragraph in the paper gave such an unfortunate impression, for our whole effort was to determine how you might save the skin from damage by spreading the radium out and thus enhancing the skin effect.

One thing more occurs to me, and that is the statement of Dr. Schmitz that the action of the gamma rays was limited to 6 centimeters, and Dr. Pfahler's argument that in the treat-

ment of the large fibroids radium would be of no use. I believe it is hardly fair to carry this over to a benign growth, for the conclusions refer to a malignant type which is more difficult to influence. You can get a much wider effect in the fibroids than in the carcinomata.

Dr. Henry Schmitz, Chicago. One of my statements has been misinterpreted. I did not state that the actual extent of the radium rays was 6 centimeters. In my opinion rays are not limited as to distance. It is a question of the intensity of the rays at any distance whether they are therapeutically active or not. The intensity of rays depends on amount and duration of the exposure. Dr. Janeway's determination of dosage in millicuries is very interesting and important. To every cubic millimeter of tissue there must be used an additional amount of emanation, and a tumor of a diameter of 12 centimeters requires 50 millicuries. The emanation tubes are placed in the tumor and left behind. In other words my deductions, using radium salts, are almost the same. If 50 milligrams element is probably the lethal amount for the treatment of carcinoma of the uterus, I agree almost perfectly with Dr. Janeway's findings.

The paper of Dr. Pfahler is very scholarly. It seems to me that the results of ray therapy in cancer of the breast have been better than in any other region of the body.

Concerning the application of the roentgen ray: We divide the chest wall in squares of about 4 inches, using 8 squares anteriorly and 8 posteriorly and one each over both shoulder and neck regions.

If we are positive that pathology is not present on one side we treat only the affected half. The filter is 10 mm. aluminum, the focal distance about 10 inches, the milliamperage 5 and the voltage 100,000. The duration of application to each square is 45 minutes. We apply a course of treatment within as short an interval of time as possible. If the patient's condition permits it we may finish the treatment in a single day.

Dr. Henry K. Pancoast, Philadelphia. I think Dr. Schmitz's reference to standardizing their results is very pertinent at this time. In a recent number of the Journal of the American Medical Association statistics were given from an article published in Germany of a series of cases of carcinoma of the breast treated postoperatively and another series of cases not so treated, in which the claim was made that the patients lived longer without postoperative treatment than with it. The matter has been taken up by a number of surgeons and a great deal has been made of it, so I think if we can get some statistics in this country showing that patients are undoubtedly benefited by postoperative treatment, now is the time to secure them.

Dr. G. Failla, New York City. I should like to say just a few words about Dr. Janeway's doses for buried emanation. In a tumor 1 centimeter in diameter Dr. Janeway uses a dose of 5 millicuries. This means that he inserts into the tumor three or more tiny glass tubes containing a total of 5 millicuries of radium emanation. The tubes are distributed throughout the tumor mass as evenly as possible, and they are left in the tissue indefinitely or until they slough out. The emanation in the meantime is decaying at the rate of one half in 3.85 days, so that the radiation is getting weaker and weaker all the time. At the end of some weeks, depending on the initial amount of emanation used, the radiation is so feeble that it has no effect on the tissue. It will be noted, therefore, that there is a great variation in the intensity of irradiation between the first part of the treatment and the last. If we want to express the dose in millicurie-hours, we multipy the number of millicuries by 132, this being the average life of the emanation. When radium is used for the treatments, it is applied for a certain time and then removed, and the effect depends very markedly on the length of exposure. Therefore, it is impossible to compare the amount of emanation buried in a tumor with the amount of radium used for a similar treatment. The only thing we can do is to compare the above doses for buried emanation in millicurie-hours with the dose in milligram-hours for *treatment with radium needles.* But in this case, if we use the needles for the same number of milligram-hours as millicurie-hours calculated in the manner indicated above, we find that the effect is considerably more marked than in the case of the buried emanation. In other words, with radium needles, unless we use a smaller dose, we get too severe a reaction.

Dr. Albert Soiland, Los Angeles. There is one point that I would like to have some information on. Dr. Pfahler has covered the subject in as splendid a way as can be, but there is one sequela that has always disturbed me. That is the tremendous swelling of the arm which is such a distressing symptom in many postoperative cases. I have had only mediocre success in dealing with such conditions, and if there is any way of helping these poor people I wish somebody would tell us.

Dr. George E. Pfahler, Philadelphia. First, in regard to Dr. Viol's criticism. I am not making Dr. Viol or Dr. Boggs responsible for anything in my paper except their own observations. If they are wrong about that—I quoted them, and I also borrowed from Dr. Viol the paper of Dr. Rutherford and did not get anything out of it except what I got out of Dr. Viol's paper. I do not say that radium cannot produce mediastinal effects, but I am saying that as it is ordinarily used by the average man in the usual amount very little mediastinal effect is produced. I know when you are using that amount you will not produce the same results which you can produce with the roentgen rays. Let us use what we have. We all have the radium and the roentgen rays. I know that Dr. Kelly did cause the disappearance of some mediastinal tumors, but he has 5 grams and he uses it at 25 cm. from the skin. With our small amounts we cannot do that. There is a place for radium and a place for the roentgen rays; let us use them both and use them skillfully and produce results. There is use for all we have.

In regard to transferring the effect of radium from cancer to the effect on the uterine fibroid, I am not transferring it; but do not forget that much of the effect you get on the fibroid is due to the action of the radium on the ovary and not on the large growth itself, while if we are working with the roentgen rays we can radiate more particularly the growth itself.

Dr. Henry Schmitz, Chicago. I would like to be permitted to say just a few words in regard to a matter that was brought up by Dr. Pfahler just now concerning the action of radiation on the ovaries.

The ovaries are in most instances 8 cm. from the uterine cavity. When radium is inserted into the uterine cavity it is usually left for twelve hours. If the erythema skin dose at 1 cm. distance is 100 mg. e. hrs., then at 8 cm. distance it would be 6400 mg. e. hrs. The sensibility of the ovary in comparison with the sensitiveness of the epithelial elements of the skin to the ray is about one-fifth of the latter. In other words, one-fifth the amount of an erythema skin dose will suffice to produce the same effect on the ovarian cells. Or, if it takes 100 mg. radium element hours to produce this effect on the skin it will take only 20 mg. radium element hours for the ovary. If we divide 6400 by 5 we obtain 1200 mg. element hours as the dosage necessary to cause degeneration of the ovarian cells. Hence the 600 mg. e. hrs. applied for uterine hemorrhages have little effect on the ovary. The cessation of the bleeding is due solely to the action of radium rays on the endometrium. Part of the endometrium receives an erythema dose, or a first degree burn, another part a second degree burn, and the portion in the immediate surroundings of the radium a third degree burn. If the endometrium is completely destroyed an amenorrhea results; if the endometrium is only partially destroyed, oligomenorrhea occurs.

Radium rays have no effect at all on the myoma if it is composed of old connective tissue. The myoma will disappear after radiation if it is chiefly made up of young, undifferentiated fibroblasts.

Dr. George E. Pfahler, Philadelphia. I just want to say that we are not differing at all. We may be differing in our terminology, but we understand each other. We do know that the ovaries are five times as sensitive as the skin and we know we are getting an effect on the ovaries. It was a surgical observation that if the ovaries were removed the fibroid would at times disappear, or even if the menopause came on the fibroid at times disappeared. We do produce an action, a direct action, on the tumor itself by the roentgen rays. Dr. McGlinn and I have proven this in one case at least in which the tumor's presence was demonstrated by abdominal section, and we knew the location and size of it, and caused the disappearance of the fibroid completely without ever stopping the menstruation at all, and just as soon as we permitted intercourse pregnancy took place and a healthy child was born. That is clean proof that the

action of the roentgen rays can be limited entirely to the tumor.

Now with regard to the treatment of the breast cases with enormous doses, such as Dr. Schmitz is giving. I used to do that, more as a convenience than anything else, until the patients began to get so sick I found I would have no practice if I continued it. Therefore, I now try to produce no constitutional effect, and I find that I cannot usually give more than four doses. At times I can give almost any amount, but generally we give only four doses and frequently we cut that down to two or one, but I find you can give two doses each day better than four every other day, and it is entirely possible that we shall come back to treating these patients every day and avoid the constitutional effects. I think we should avoid them, for I believe they are harmful to the patient. I do not know just why they occur, but I think it must be due to the radiation. I had one patient to whom I gave eight doses, and then I cut down and down until I was giving only one. Then she said, "Doctor, I get sick every time and I would like to have all the treatment to-day and get it over with. I want it and I will take all the risk." So I gave her sixteen doses that day and she did not get sick at all.

Dr. Soiland's swollen arm problem is not new to us as radiologists; it was a surgeon's problem long before. We know it may be due to scar tissue around the blood vessels, or it may be due to malignant disease, or both. If it is due to malignant disease we must get rid of that malignant disease. Frequently we can get rid of it by treating the area either with radium or roentgen rays. If I can feel any hard mass I use radium locally over this mass or cross-fire over it with the roentgen rays, but roentgen rays and radium must not be used through the same area of skin. In addition, I instruct the patients how to apply an elastic washable cotton bandage and have them apply it every day and keep on applying it until you can coax nature to help you out.

CONGENITAL (HEREDITARY) ABSENCE OF MIDDLE JOINT OF LITTLE FINGER

By T. C. BONNEY, D.D.S.

ABERDEEN, S. D.

Congenital skeletal anomalies are not rare, but we have felt this case worthy of report as it is possible to trace the condition back for three generations.

In the patient (Mr. J. H., age nineteen years), the little finger shows no sign of a middle joint, and it was impossible to make out any irregularity of the bone on very firm pressure. It was therefore with some little surprise that we noted the rudimentary joint as shown in the accompanying radiograph.

Tracing the condition back we found it to be present in the father and in the paternal grandmother.

Of three brothers, one has the condition present in the little finger, one in the little and ring and the third in the little, ring and middle fingers, it being bilateral in all the persons affected.

TREATMENT OF ANGIOMATA WITH RADIUM*

By WILLIAM S. NEWCOMET, M.D.

PHILADELPHIA, PA.

MANY methods have been employed in the treatment of angiomata, and here, as in other fields, where a great number of remedies have been recommended, none has been found to be perfectly satisfactory. There is not a class of cases coming under our observation that will tax the judgment of the operator to a greater extent. In the majority, treatment of the lesion is desired for the cosmetic result, and in no way does it disturb the health or comfort of the individual. In another group the mass interferes with the free movement of some part, as the eyelid or mouth, or it may be subjected to constant irritation from contact with clothing, and in a very small group life itself may depend upon its prompt removal.

The use of radium should be the ideal method for the destruction of all nevi. The high radiation penetrates the tissues, causes an inflammatory reaction, and a certain number of cells, scattered through the tissue, are destroyed, but not *en masse*, as observed when caustics, hot water, CO_2 ice, and the various electrical methods are employed. The actual practice often proves the fallacy of these theories. There are cases, however, where some of these forms of treatment are preferred to radium, for instance, those lesions in the neighborhood of the hairy portion of the face, those which are quite small and show no tendency to spread, or the very superficial hemangiomata.

The nevus should be treated as soon as possible after discovery. The usual history of these cases shows spontaneous enlargement. They may remain quiescent for years, then from no assignable cause, or after an acute illness, suddenly take on a new growth, or undergo malignant degeneration. In the course of a few days or weeks, rarely longer, they often extend from a very small area to many times the original size. If they occur at birth, their destruction in early childhood will allow a regeneration of the skin that is not to be expected in later life. But it must be remembered that all these cases greatly improve as time passes, barring those unfortunate instances where complications mar the result.

For convenience in treatment, we may divide these lesions into three classes; (1) the hemangiomas, (2) lymphangiomas, and (3) the pigmented angiomas. While being quite distinct, they will at times blend so closely as to make the line of demarkation almost impossible, although as types they are distinct entities with a different arrangement of the tissue structure. Excepting the small pigmented mole, which is very common, the hemangioma is the usual type. These are again subdivided according to the predominating class of vessel which they contain, but their treatment by radiation is governed not so much by their tissue structure as by their size and distribution.

Small hemangiomas, like the pigmented variety, are easily treated by many simple methods with good results. But as the lesion increases in size so does the difficulty in its treatment. Several cases have come under observation where the whole arm and part of the body were involved; in one, an *x*-ray examination of the part showed that the bones of that member had developed to a greater degree than the opposite side—in other words there was an active development of the whole area; in these cases treatment seemed inadvisable.

Where they exist upon the face and cover a considerable portion of it, the normal tissues are to a great extent replaced by the vessels, which after contraction leave principally scar tissue. The epithelial elements are necessarily widely scattered, and under ordinary circumstances are most sensitive to any

*Read at the Fifth Annual Meeting of THE AMERICAN RADIUM SOCIETY, New Orleans, La., April 26, 1920.

FIGS. 1, 2. W. S. (CASE 147). Nine months. 6284 mgh. in seventeen treatments. In tubes from 50 to 140 mg. The last picture was made about the time when the reaction of the radium was disappearing. The neck was powdered, which gives the roughened surface noticed in the photograph. Notice in the first picture the size of the vessels.

form of radiation. The more highly they are developed the greater their susceptibility. These must to a great degree be replaced by the connective tissue elements. Naturally there is no form of treatment which will give a normal skin, with the usual hair or down, involuntary muscle and glandular structures, all so essential in the face for the changes caused by expression, blushing or the change of temperature.

These facts must be considered when such lesions are presented for treatment, and the patient should be fully advised lest disappointment follow the absence of normal skin as the ultimate result.

Two cases of lymphangioma came under observation, but the result of treatment was not satisfactory. One supposed pigmented mole proved to be a melanotic sarcoma, and while local radiation might have been selected, in this instance the diagnosis was most important in the light of subsequent developments. The history of a sudden enlargement of an ordinary mole should always be looked upon with suspicion. But under ordinary circumstances, large moles, even covered with hair, if they have a deeply infiltrated base, give good results under radiation.

TECHNIQUE

The development of a standard technique is absolutely essential, and the results depend largely upon obtaining the proper amount of radiation. In determining the dosage it is better to underestimate it than to produce reaction that results in ulceration. If it should be necessary to radiate the part again, remember it will not tolerate the dosage of the first application. The amount usually given is about an erythema dose, which must be judged according to the applicator used, the filter and the skin distance. The last factor is by far the most important, and varies according to the depth of the nevus. If it is deep, the applicator is placed from 3 to 6 centimeters away and moved frequently to produce "cross-fire" effect.

But in the more superficial types, the applicator is placed 1 to 3 centimeters skin-distance. Naturally the length of exposure is increased with the distance.

Most writers upon this subject have treated these lesions purely from their surface, to a great extent disregarding their depth, which would seem a most potent factor. Remembering the rule of radiation, the applicator should be elevated from the skin to such a distance that by the number of movements the deep parts of the nevus will receive about the same amount of radiation as the more superficial structures.

Flat applicators of radium, tubes of radium and emanation have been used. Flat applicators were used with the idea of obtaining uniform radiation over a given surface; but as the surface of these lesions was rarely flat, and furthermore was never the size and shape of the applicator, they were discarded, and tubes were used exclusively. In treating large areas it is necessary to have about the same amount of reaction over the whole surface, thus obviating the "checker-board" effect, as it is extremely difficult to join the edges of the radiated parts.

Great care should be taken with the skin that adjoins the nevus, particularly if it ends abruptly. It will be found many times more sensitive, and will break down while the vascular tissues appear to be unharmed. Protection of the skin with lead at the border line is not sufficient, and here again distance appears to be the factor. If the protecting filters are used they should extend slightly over the edge of the nevus rather than expose the skin.

In cases where previous treatment consisted of CO_2 ice, hot water, iodine or electricity, and was not sufficient to eradicate the lesion, the same care must be observed in applying radium as though the part had been formerly radiated.

Angiomata that appear upon the face, and extend into the mouth or nose, must be given great care in radiating the two surfaces, as the skin appears to be somewhat

Figs. 3, 4. M. M. H. Four months. Hemangioma of the face. The gangrenous area was present when the baby came under observation; the mother could give no reason for it. 1590 mgh. in 25 sittings about three hours each. Radium 50 mg., 1 mm. lead and 2 cm. gauze filter. Treatment had no effect upon the gangrenous area.

Figs. 5, 6, 7. H. D. (Case 299). Hemangioma of upper lip. Notice the ulceration; no cause to explain it. Child was seven months old when treatment began, and at no time was its feeding interrupted. Notice most of the lesion was covered with healthy skin, the blood vessels being deep, except in the ulcerated area. Treatment, radium 345 mgh., 4 applications; 40 mg. for 2½ 20 mg. for 3 hours. Applied July 12, 24, Aug. 18, 29. Applied in tubes 1 mm. lead, ¼ gauze filter.

more susceptible, and if one or the other had been radiated at a previous time, that fact must not be forgotten when radium is to be applied to the other surface.

It is impossible at this time, to give any exact dosage, owing to the wide variation in the size and position of the lesions and the difficulties that often attend the application. However the correlation of these figures will in time give a better idea of uniformity and will likewise improve our results.

COMPLICATIONS

The reaction set up by radium causes a low grade inflammation of the radiated part,

FIGS. 8, 9, 10. K. T. Fifteen months. Had been treated by the injection of boiling water. The gangrenous areas shown in the first picture. Second picture shows the lower portion of the mass treated by radium, while the former area was healing. Third result after radium over the whole area. Notice the depth of the mass as seen by comparing the nose and mouth. 4936 mgh. in in sixty treatments; 1 mm. lead and 2 cm. elevation; 5 to 20 mg. tubes for 3 to 4 hours.

and this gives rise to a burning sensation or an itching. It is often difficult to keep young children from rubbing or scratching the affected area even when protected by bandages, and thus producing a troublesome ulceration, with necessarily more scarring than would naturally be expected, as a result of the infection which often occurs from the breaking of the skin.

An unfortunate coincidence occurred while treating a young girl five years of age who had a pigmented angioma 1½ centimeters wide and 3 centimeters long, with a very vascular base, situated on the side of the nose. She contracted measles from the other children in the family when the radium reaction was at its height. The whole face became swollen to an alarming degree; the area became gangrenous, and the general systemic reaction was severe. When the child recovered an annoying ulcer was left which healed, but did not entirely remove the angioma. The result was not pleasing but further treatment was declined.

Three cases have come to notice where the nevi had undergone a spontaneous local gangrene from no definite cause. In all instances the babies were only a few months old when seen, and the nevi were large and

Figs 11, 12. T. M. Hemangioma of elbow, ninth month. Gradual enlargement since birth. 11 mgr. tube of silver. Sixteen applications in three months. Total 637 mgh.

very blue. They were given close attention for a few weeks, but there seemed to be very little change in the process, and it was decided to begin treatment. Two produced very good results, while the third passed from observation. The ulceration had very little influence upon the contracting nevi, but, as might be expected, a scar was left over the affected area.

[illegible] H. S. Hemangioma. An attempt was made to [illegible] it with CO ice. An ugly granuloma developed [illegible] the mass that bled easily and discharged [illegible]. Treatment, radium 2248 mgh. in [illegible] treatments.

The use of CO_2 ice in two cases, and in another hot water injected into the tissues, caused large gangrenous areas with foul discharges. Considerable granulation tissue protruded from the ulcerated areas in one case, and for a time it was thought to have undergone a sarcomatous degeneration. All, however, yielded very good results with some slight scarring.

There is no doubt that the foregoing methods have some degree of usefulness when applied in suitable cases and by experienced operators; but in very large vascular nevi, their value is doubtful if not dangerous, and under such conditions radium can be used with a much greater degree of safety, and decidedly less scarring.

DIFFICULTIES OF APPLICATION

The irregularity in the size, shape of the lesion, depth, size of the vessels, age of the patient, amount of radium to be employed and the manner of its application, are all important factors to be considered in the treatment of angiomata. Are the results better from the use of small amounts, as 10 milligrams, or from larger amounts, as 100 or 200 milligrams? The question is still un-

settled, although the outcome from both has been satisfactory.

Some annoyance has been caused by the slipping of the applicator. This was especially liable to occur in young children, and to avoid this complication a cast was made of all cases and the radium and filters attached to it. If there is any change in the contour of the skin due to muscular movements, the cast will automatically readjust itself after the parts assume their natural position, while if a pad or cone is used and the dressing slips, the whole prescribed area as well as the direction of the treatment has been changed.

SELECTION OF CASES

The use of radium in the destruction of small nevi would not be recommended, since good results may be obtained by many other methods. The superficial hemangiomata and the thin pigmented mole extending over a large area can be successfully treated by the quartz lamp or high frequency. But if radium is to be used a very careful technic must be followed, lest the after-effects be far worse than the original condition. When angiomas with large vessels extend deeply into the tissues in the neighborhood of large nerves and important structures that cannot be destroyed, then radium performs its greatest mission.

In a list of about 200 cases of angiomata of all forms, 5 died, 2 were infants with large hemangiomata, 2 women and 1 man proved to be types of sarcomas, 86 were selected for treatment with radium, and of these 7 were failures and 17 disappeared from observation. The result in 62 cases was all that could be desired, with very little scarring and no after-effects.

SEQUELLAE

The formation of keloid often arises from a too intense radiation. But it must be remembered that the skin of certain individuals develops keloids under very slight provocation, in some instances even upon the slightest amount of burning, especially if it extends to the degree of vesication.

Telangiectasis is often most annoying and will occur at times even when the greatest care is exercised. Too long and too intense erythema is usually the cause, but the individual peculiarity of the skin must be taken into consideration. Its occurrence must therefore be regarded as accidental.

Conclusions as to the result of treatment must not be adopted until several years have passed, as it is not unusual for the skin to be perfectly clear at the time the treatment has ended, and about a year later develop quite a number of telangiectatic areas, with at times annoying keloids. But a still more annoying complication seen in two cases treated with radium and in several treated by the *x*-ray was a secondary ulceration in the site of the scar appearing a year to three years after treatment.

SUMMARY

In radium, like the *x*-ray, we have an agent that is capable under some circumstances of doing considerable harm; therefore it must be employed with great care, especially where it is impossible to judge exact dosage. It should be remembered that as a rule people live in the present and to a great extent forget the past. Therefore if a scar or a slight discoloration remains, it may be judged a bad result, with absolutely no regard to the former condition, even if it should have been quite repulsive.

Early treatment of the various forms of hemangiomata should be the absolute rule. The likelihood of rapid enlargement should always be borne in mind with the pigmented angiomata this enlargement is not so likely to occur. In either class the sooner these growths are removed the better will be the result.

DISCUSSION

DR. E. C. SAMUEL, New Orleans. There is very little that I can add after hearing the very excellent paper of Dr. Newcomet; but in our clinic when a case of one of the types that he

describes presents itself we promise neither the patient nor the parents anything at all, but make them understand from the beginning that we are just as likely to have failures or trouble as the result of the treatment as to have a good result. They are also instructed that they must keep in touch with us for at least six months. We do not promise anything under that time. I am very anxious to hear what Dr. Newcomet has to say about the length of time. In our cases it is eight months to a year. We use a little different technic from that described by him, using about 25 milligrams of radium with 2 mm. of brass, and about three turns of gauze as filter, going to four portals of entry in the course ordered, using the center as a pivot and working out from the center, giving a treatment every five days. I used in the beginning very large doses, 100 to 150 milligrams, and found that the cases in which I produced an erythema dose did not do so well as those with the so-called fractional dose, as we are using it at present. We have had some very excellent results, particularly in the hemangiomas of the lip. We have an Italian child under treatment now that we have been treating for a year and a half. He had at first a tumor anterior to the ear about the size of an adult fist that everybody in the city had turned down. Luckily the child was from New Orleans. Nobody wanted to attempt anything and the growth had started to ulcerate just at the center. Dr. Matas asked us to see what we could do (I asked the mother to come up today with the child but I guess the rain has prevented her coming) and now the growth has almost disappeared. We did not produce any erythema at any time. It is just the same as with the lip and one or two of the tongue cases. We have found with children that it is very difficult to hold any kind of applicator in contact with the growth. The cases that are over-radiated show some signs of telangiectasis, but the cases in which we use the fractional dose method have showed no such signs and I have been able to follow the majority of the cases now for three and a half to four years.

Dr. James T. Case, Battle Creek. I wish the author would please tell us specifically about his technic. How much radium he uses and for how long. I am especially curious to know how he kept the applicator in contact with the tongue. If he will give us these details I will appreciate it very much.

Dr. George E. Pfahler, Philadelphia. I have had a few nice results in these cases. I, also, am giving less than an erythema dose and I think the first thing to be careful about is not to be in a hurry. I tell these patients that it will take a year or two, or perhaps longer before they can be well. I think the tissue changes come slowly in these cases and we had better go too slowly than too fast. That is the general principle. We have all learned these principles by feeling our way carefully and I sympathize with Dr. Newcomet when he answers Dr. Case. I do not use any set rule in my work, except that I do not produce an erythema. In this way, in my experience, you get a gradual shrinking of the growth and results that in many instances are beautiful. I think the one thing is to go slowly and be careful. I do not think you can lay down any definite rule about using so and so much radium at such and such a distance in the treatment of every angioma; I cannot. I believe you will have to vary your treatment with each case. I would like to ask Dr. Newcomet, or Dr. Case, if he has used radium needles in the treatment of these angiomata and what has been the result. In some of the large cases I think they should be considered but I have not used them.

Dr. William E. Newcomet, Philadelphia. The detailed technic used in the treatment of the cases has been placed under the individual illustrations, the reason being that so far a detailed technic has not been adopted. I am still in the beginning stage, but two or three things have developed that have been of use. One is the use of the cast. It has, no doubt, saved me from bad results. It is composed of some dental compound from which a very good cast of the nevus is obtained and kept in close contact with the skin while the child is under treatment. To get the same amount of radiation over the whole area at the same time is most important, if you expect good uniform results. You must have the same amount of radiation over the whole mass, not in one corner, for if a second application is needed it will be very difficult to join a bad edge produced from the first application. It takes any-

where from six months to two and a half years and in one instance it took three years to obtain the desired results. In the illustration which shows the mass at the neck to be almost half as big as the child's head, the mass absolutel ycontracted in six months. We produced no erythema and, if the treatment is successful, no scarring. How sometimes I do it and sometimes I do not, I do not know. I wish someone would come to my assistance and tell me what happens in one case and what does not happen in another case, for I am at a loss to explain. It is a hard problem. There seems to be no uniformity in the dosage for the nevus. You can take two hemangiomas and one will stand twice the radiation that the other will. Personally I do not care for fractional doses. I, along with the rest of us, frequently use fractional doses, but far preferable is one good dose that will do the work. I believe that in after years, we shall have less trouble from complications in these cases than from those in which the fractional doses have been used. And even with the fractional doses we are at times likely to get telangictales where the dose is brought just to or beyond the erythema.

As to the use of the needles, it is a matter of judgment. It may be dangerous to employ them where the veins were large, not on account of bleeding, but embolism should be thought of, or a phlebitis. The radiation from needles is too localized. Furthermore these cases contract easily, and with more uniformity from a general radiation than from the small divided doses. For this reason I am more inclined to stick to an applicator, which is moved frequently, in preference to needles.

In regard to the differences in the child and the adult, the growing tissues of the child give a far better result than the tissues in the adult. It cannot be too strongly emphasized that all angiomata should be treated as soon after their discovery as is possible.

USEFUL ATTACHMENT TO A BOWEN DEVELOPING TANK*

By A. JUDSON QUIMBY, M.D.

NEW YORK CITY

THE introduction of the Bowen tank into roentgenography has greatly simplified and facilitated the dark-room work; but all the older operators who were familiar with plate development had acquired an appreciation of mechanical devices for plate rocking which gave added value to the plate, shortening the exposure and increasing brilliancy, and in addition, conserved time and labor. Titubation was especially important in tray development, because the horizontal position of the plate in the developer did not allow the rapid removal of the solution immediately in contact with the emulsion surface. This essential can be fully appreciated by all who are familiar with photography in any of its branches, and especially by those having a knowledge of photographic chemistry.

The Bowen tank, which permits the vertical suspension of the plate or film in the developing solution, partially compensates for lack of plate movement by allowing the developer which has acted upon the emulsion to drop, as a result of its increased specific gravity, to the bottom of the tank, maintaining a circulation over the plate or film surface; but as this circulatory movement of the developing solution is in one direction, there is an inclination, especially in strong developer, for vertical streaking to take place. The writer's practice has always been to shake the plates or films in the developing tank until the image appeared, and then allow the remainder of the development to take place without disturbance; but in doing this work it has been observed that more brilliancy and better value for a given amount of exposure was obtained by maintaining plate motion during the entire process.

* Read before the Eastern Section of The American Roentgen Ray Society, Atlantic City, N. J., Jan. 31, 1920.

In attempting to solve this problem so as to reduce it to a mechanical process, the writer observed that very slight movement of the plate set up a swirl of the fluids far in excess of the plate movement, and therefore concluded but little motion was necessary, and after considering a number of probable methods, evolved the device herein illustrated. This consists of a motor about the capacity of the average 16 inch fan motor, a suitable gearing for reducing speed, which is transmitted to a cam shaft and allowing a stroke of from 20 to 40 per minute; the rate of this stroke can be further controlled by attaching a rheostat to the motor. The cam shaft drives a short fulcrum bar which is attached to a flat carrier resting upon the flat surface of the tank, intended to support the ends of the plate or film rack. If desirable, a second fulcrum bar may extend from the end of the first to the opposite end of the developing tank to a similar flat carrier, resting upon the plate rack's support. The carriers are passed through a hole in the side of the tank on a level with the supporting ledge and the distal end is maintained in a similar hole penetrating the partition between the portion of the tank containing the developing solution and hot or cold water section.

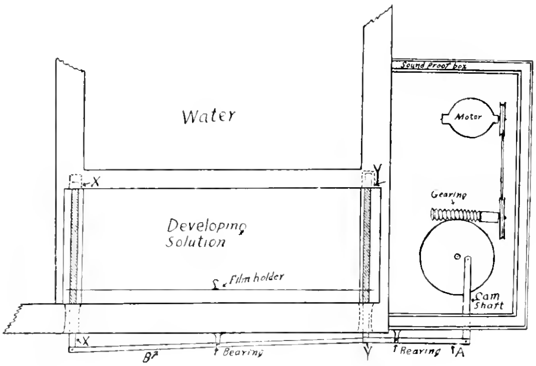


Fig. 1. A Useful Attachment to a Bowen Tank to Maintain Motion of Plates or Films during Development. A and B, Transmission Levers. X and Y, Plate Rack Carriers. If only one is used a 5/8 in. stroke is necessary. If one at each end of tank a 1/4 in. stroke will do.

The device herein illustrated and described is fitted to the form of tank sections running transversely; if tank sections run from front to back the motion of the cam shaft can be carried to the plate rack carrier by a rearrangement, one carrier by direct attachment to the cam, the other by the same arrangement as above described.

Having some old plate racks and gearing in my laboratory, I constructed apparatus, which has been in use two years, out of a discarded fan motor and the gearing of an old K-K titubator, and used pieces of the handle portion of plate racks to make the driving shafts and plate rack carriers, so using the same material as the plate holders, which are composed of alloys very resistant to the corrosive action of the developing solution.

In my experience the single carrier has been found to impart motion to plates sufficient to prevent streaking, hasten development, and add brilliancy, and also be a great factor in economy of time. The stroke of the horizontal carrier which supports the plates should be 5/8 inch if a single bar is used, and 1/4 inch if the bars are placed at each end of the tank. I have also found it best to continue plate motion throughout the entire development of the plate, and the best stroke period is about 30 per minute. The motor and gearing are enclosed in a sound-proof box.

OSTEOCHONDRAL TROPHOPATHY OF THE HIP-JOINT. LEGG'S DISEASE. REPORT OF FOUR CASES.

By W. E. REILEY, M.D.

CLEARFIELD, PA.

SINCE the meeting of the American Orthopedic Association in June, 1909, when Arthur T. Legg cited five cases of what he then differentiated as "an obscure affection of the hip-joint," numerous reports covering several hundred cases have been published in this country. These have either confirmed the original observations or have added some new details to the knowledge of this condition.

It has seemed a singular coincidence that in a clinic where joint disease of childhood is a rarity, four cases should have come under observation within the brief period of fifteen months thus during a period of ten years at our hospital, making the incidence of this pathological condition exactly the same as for congenital dislocation of the hip and tuberculosis of the hip-joint.

The following report of four cases, only one of which was treated in the hospital, does not add any new observations, but confirms the findings of some of the other writers. The ages at onset range from six to ten years; two were boys and two were girls; in three cases the right, and in one the left hip was affected. Pain was observed in only one case and was very severe until the joint was immobilized. All showed marked thickening of the neck of the affected femur, but there is no involvement of the non-affected side. The children were all robust and there was a distinct difference in the muscular development of the lower extremities of the two boys, while the girls coming under observation earlier did not show it to the same extent at the time of the first examination. The appearance of the acetabulum on the *x*-ray plate is considerably altered in two and slightly in one. Its density is somewhat variable and the rim irregular or roughened. Two show an area of decreased density of the diaphysis bordering the epiphyseal line, which is irregular in all. A history of traumatism was obtained but once, no reliable statement was obtained in one and traumatism was absolutely denied by two. No Wassermann reactions were done. Careful examination failed to elicit any of the stigmata of hereditary syphilis and hence it is not entertained as an etiological factor in this series.

Report of Cases.

Case I. P. F. Boy, eight. October, 1916, left hip. Always healthy and robust. Two years ago noticed limp after prolonged and active exercise, but no pain at any time. Very slight shortening; motion noticeably limited in abduction, but no muscular spasm. Six months ago the mother became alarmed over the perceptible muscular atrophy of the left thigh and leg. Fell from a tree a short time before the limp first attracted attention. Roentgenogram shows the characteristic

Fig. 1. Case I. October 1916. Left hip: Two years' duration. Shows a very much flattened and thinned epiphysis which appears to be divided into several pieces. Neck much thickened.

*Thesis presented with application for membership in The American Roentgen Ray Society, 1919

changes all present at the first examination and are probably terminal. Case came under observation but once.

CASE II. Z. S. Girl, eight. December, 1916, right hip. Always very healthy but has moderately enlarged tonsils. For the past ten weeks has had a limp after prolonged effort. For two weeks pain at night in thigh above the knee very severe. Never seems to have had any fever. Had a hard fall when a baby but no knowledge of any traumatism since. Roentgenogram at this time shows lessened density of the neck along the epiphyseal line and lack of definiteness of the line. These findings were not fully appreciated at this time and it was thought that this was a case of early tuberculosis of the hip-joint in which the bony changes had not yet become apparent.

FIG. 2. CASE II. December, 1916, right hip; twelve weeks' duration. Shows lessened density on the shaft side of the epiphyseal line.

FIG. 3. CASE II. October, 1917. Ten months later, all of the characteristic changes of Legg's disease may be seen.

Second x-ray examination, October, 1917, shows the classical changes all present now. The epiphysis is much flattened and of irregular density, the articular space apparently enlarged and marked hypertrophy of the neck.

Third examination, April, 1919, shows the terminal stage. There has been no further change since the second examination, which would seem to prove that early immobilization in this case has prevented the usual amount of flattening of the epiphysis. There is no noticeable limp.

CASE III. S. P. Boy (Slavish parentage) eleven, May, 1917, right hip. Symptoms have been of one year's duration. Poor history obtained because no interpreter available at the time. Has a very decided limp and abduction markedly limited, but no muscular spasm. Roentgenogram shows the characteristic changes at the time of the first examination; flattening of the epiphysis, irregular density, thickening of the neck and

FIG. 4. CASE III. May, 1917. One year's duration. Decided limp and abduction markedly limited. All of the characteristic changes now present.

a rather marked change in the contour of the acetabulum.

Second examination, July, 1917, shows an increase of the irregularity of the acetabulum and increased density of the epiphysis.

Case IV. M. R. Girl, ten, January, 1918, right hip. Has always been robust. For the past four months has developed a limp after prolonged exercise, without any pain. Attention first attracted by mother having noticed the atrophy of the muscles of the affected extremity. There is no shortening, no limited motion and no muscular spasm. The lameness increased to such an extent during the two months following that a short spica was required.

Fig. 5. Case III. July, 1917. The amount of roughening of the acetabulum has increased and the epiphysis seems to be denser.

Second examination, July, 1918, shows accentuation of the previous findings. The epiphysis shows some increase in size and density, the neck is very much thickened and there is a flattened x-ray appearance of the acetabulum.

CONCLUSIONS

The fact that two of these cases had been previously diagnosed as tuberculosis of the hip-joint emphasizes the importance of careful differential roentgen diagnosis in all cases of hip-joint disease.

The number of cases of Legg's disease coming under observation in this locality seems to be out of proportion to the number of children suffering from other hip-joint

Fig. 6. Case IV. January, 1918. Pronounced flattening of the epiphysis with change in density of the bone bordering on the epiphyseal line. Change in the shape of the acetabulum is apparent.

Fig. 7. Case IV. July, 1918. The characteristic changes are all present at this time. There has been considerable change in the shape of the acetabulum.

affections and would apparently corroborate the statement of Taylor and Frieder: "It is evidently not very rare and its inclusion with cases of hip tuberculosis must have seriously distorted the symptomatology and statistics of that disease, especially as to the results of treatment."

BIBLIOGRAPHY

LEGG, ARTHUR T. An Obscure Affection of the Hip-joint. *Boston M. & S. J.*, Feb. 17, 1910.

LEGG, ARTHUR T. Osteochondral Trophopathy of the Hip-joint. *Surg. Gynec. & Obst.*, March, 1916, p. 307.

TAYLOR, HENRY LING and FRIEDER, WILLIAM. Quiet Hip Disease. *Surg., Gynec. & Obst.*, Feb., 1916.

ELY, LEONARD W. Legg's Disease. *Ann. Surg.*, Jan., 1919, p. 47.

ROBERTS, PERCY WILLARD. The Etiology of Perthes' Disease. *J. Am. M. Assn.*, Nov. 10, 1917, p. 1598.

WATKINS, W. W. Osteochondritis Deformans Juvenilis, review of literature and illustrations of case of Perthes' disease. *Southwestern Med.*, March, 1919.

FACTURES OF THE BONES OF THE FACE

By CHAS. F. BOWEN, M.D.

COLUMBUS, OHIO.

ROENTGENOLOGISTS are frequently called upon to examine the bones of the face, to determine the presence or absence of fractures. This is readily determined in the case of a few of the bones, but in others the usual posterior-anterior and lateral views are really of very little help, and if a fracture is actually seen, the extent of the damage done is not always apparent.

In studying head plates made in the Waters position, I was impressed with the clearness with which the outlines of the malar and superior maxillary bones and the zygomatic arch is brought out. I was convinced that this position or modification would be best suited to demonstrate certain fractures of the face.

Fractures of the face are the result of a crushing blow which produces a caving in either of the orbit, maxillary antrum or the zygoma. Such accidents are soon followed by considerable swelling of the soft tissues, which makes an accurate examination impossible. Ten days or two weeks usually elapse before the soft tissues return to near normal, when it is discovered that the cheek is sunken or depressed. It is then usually too late to elevate the fragments and to restore the facial lines to somewhere near normal. It is evident, then, that the extent of the caving in or the displacement of the fragments is of the utmost importance. With

FIG. 1. RAY PASSING THROUGH TOP OF HEAD.

Read before the Middle Section of THE AMERICAN ROENTGEN RAY SOCIETY, Chicago, February 22, 1920.

radiographs made in the position described below, the injured parts can be readily compared with the opposite normal side and the exact condition explained to the surgeon and patient.

Plates are made in a position similar to the usual posterior-anterior frontal sinus position, either sitting or lying, except that the chin and nose are touching the plate. The ray is centered over the central incisors and passes straight down through the top of the head (Fig. 1). A piece of cardboard between the head and the cone will help to steady the head and protect the hair.

FIG. 2. MAXILLARY ANTRUM OBLITERATED ON ONE SIDE.

FIG. 3. SHOWING A SERIES OF FRACTURES.

Fig. 2 shows at a glance that the maxillary antrum is obliterated on one side, which was caused by the malar bone being driven inward. There has been a fracture of the frontal process of the malar bone (1) with a displacement into the orbit of $\frac{1}{4}$ inch, a fracture of the zygoma (2), and a fracture of the outer wall of the antrum (3). These three fractures are the only ones which show in the print, but of course there was a crushing of the thinner bone plates of the upper part of the antrum when the outer wall of the cavity collapsed.

Fig. 3 shows fractures as follows: Fracture of the external angular process of the frontal bone (1), superior maxillary extending from the orbit into the nasal cavity (2), malar bone through the body (3), malar bone through the zygomatic arch (4), zygomatic arch (5), zygomatic arch (6).

Such plates show at a glance the amount of destruction of bone and the extent of the deformity or caving in of the cavities which exists. The deformities can be corrected, or else the patient told and shown the extent of the deformity which is going to result from the accident, and perhaps damage suits can be avoided.

TELEROENTGENOGRAPHY OF THE SELLA TURCICA WITH OBSERVATIONS ON ONE HUNDRED NORMAL CASES

By C. HARVEY JEWETT, M.D.

The Clifton Springs Sanitarium

CLIFTON SPRINGS, N. Y.

THE original idea in carrying out this piece of work was an attempt to establish some fairly definite standard of size, shape and normal variations of the sella turcica in apparently normal healthy individuals, so that one might have some basis for comparison in the interpretation of questionable cases.

Teleroentgenography offers the most accurate method of reproducing the exact size of the sella turcica, and direct lateral plates were used in all cases. It was found by experimentation that an object 1 cm. in diameter placed at a distance of 4 inches from a photographic plate with a plate target distance of 15 inches, resulted in an enlargement of approximately 35 per cent of the diameter of the object. This experiment would simulate the conditions of an ordinary short plate target distance. With the plate target distance increased to 5 feet the increase in diameter was only approximately 5 per cent. It was also found possible to obtain a clearer plate at this distance. The work was done using a medium focus Coolidge tube with duplitized films and double intensifying screens.

The individuals selected for the work ranged in age from sixteen to eighty-one years, with an average age of thirty-two. Sixty-eight were females, and thirty-two males. The weight ranged from 86 to 200 pounds with an average of 146 pounds. All were supposedly in good health, with no gross evidence of internal glandular disturbance. The measurements of the sella turcica were taken with calipers, obtaining the longest antero-posterior diameter in a general horizontal plane. The vertical measurements were taken by bisecting a line drawn between the anterior and posterior clinoid processes, and dropping a line very nearly perpendicular to the deepest point of the floor of the sella. In some instances where vertical measurements were impossible they were omitted from the calculations. The antero-posterior diameter of the skull was taken from the frontal prominence to the occipital protuberance externally, and the vertical diameter from the vertex to the base of the sphenoid.

On studying the roentgenograms of the sella turcica it was found that they could be roughly divided into eight groups, ranging according to their general structural characteristics regardless of size. For purposes of classification a ninth or miscellaneous group was added, containing a number which did not fall into any definite class, but showed unusual variations. Several rearrangements of the groups resulted in some variations of classification each time, due to the fact that certain groups simulated each other very closely, and all shades of variation were found. In general, however, the most satisfactory classification is as follows:

GROUP I showed structurally long, slim, curved posterior clinoid processes with absence of anterior clinoid processes. This group closely simulates Group III, except for the fact that the latter has a small light anterior clinoid process. It is noteworthy that the statistics of this group show the lowest average age (with the exception of one other group of the same age) and the highest average measurements of the sella, both horizontally and vertically, and the highest average antero-posterior cranial measurement.

GROUP II shows nearly vertical lightweight posterior clinoid processes with wide open infundibulum and absent or extremely indistinct small anterior clinoid processes.

This group is similar to Group VIII, the latter having distinct anterior processes. The statistics of this group are not distinctive, except for the fact that it contains the largest number of cases.

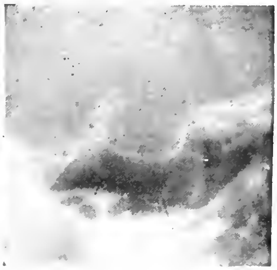
Group III, as noted above, is similar to Group I, except for the presence of small, light, anterior clinoid processes projecting horizontally backward. The small size and the direction of these processes are the only definite distinctions between this and Group VII. There are no distinctive features regarding the statistics.

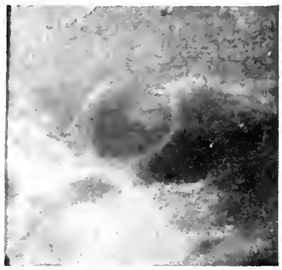
Group IV is characterized in general by a very heavy anterior clinoid process, projecting directly backward and occupying a somewhat lower level than the tip of the posterior processes. The group might also be considered similar to Group VII, except for the difference in the construction of the processes. The average height in these cases is the greatest.

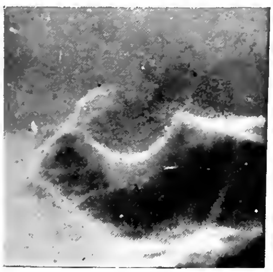
Group V gives the appearance of a shallow floor with very indistinct thick processes and wide infundibular spaces. The statistics show this group to be of the highest average age.

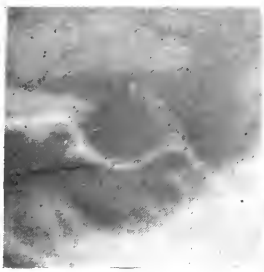

Group 1

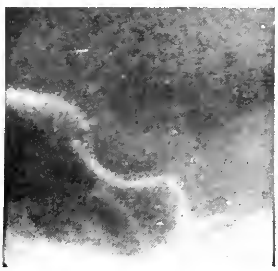

Group 2

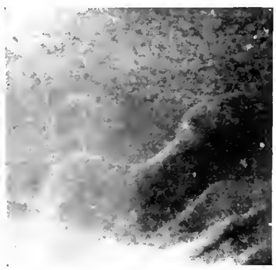

Group 2


Group 4


Group 3


Group 3


Group 5

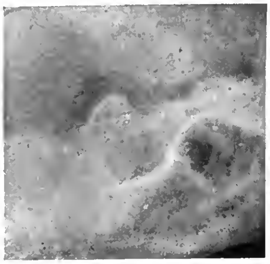

Group 5

Group VI gives the appearance of complete bridging over of the sella turcica, most of the cases showing heavy processes. It is possible that slight rotation of the head might show a different picture, but this was not observed in several cases that were repeated. The appearance of bridging over in this case is undoubtedly due in most instances to the superimposing of shadows. It is interesting to note that the measurements of the sella turcica were the smallest in this group, and that as many as 10 per cent of the 100 cases studied showed bridging over. This group also shows the shortest longitudinal and the longest vertical cranial diameters.

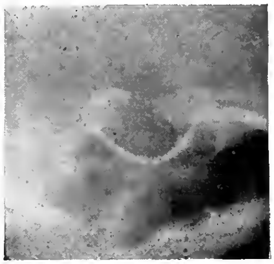
Group VII, as previously mentioned, closely simulates Group III, but the most distinctive cases of this group show anterior and posterior clinoid processes of about equal length with small infundibular spaces. This group is characterized by the greatest weight and the shortest height, with the exception of Group IX, in which the height is the same.

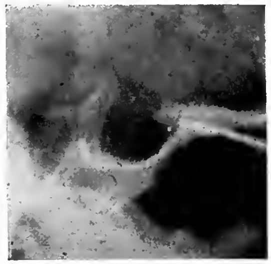
Group VIII, as cited above is similar to Group II, having thin, nearly perpendicular

posterior clinoid processes, with wide infundibular spaces; but this latter group, in addition, has small but distinct anterior processes. Like Group II it contains a large number of cases. The average weight is the lowest.

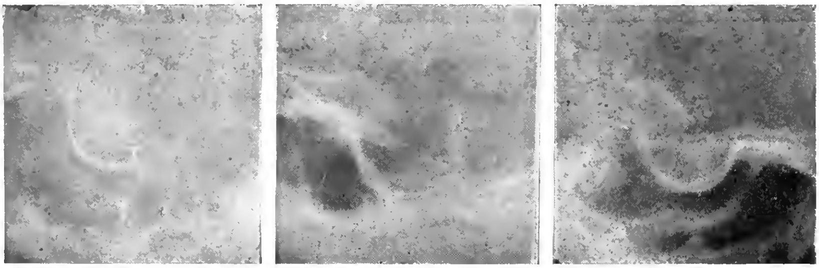

Group 6


Group 6


Group 7


Group 8

processes. Three cases show double anterior clinoid processes with considerable variation in the rest of the sella. Two of these cases were repeated, thinking that position might play a part in the variation, but the same picture was observed. This group shows next to the smallest longitudinal, and the smallest vertical cranial measurement.


Group 9

Group IX is composed of nine cases nearly all of which are different, and all of which show great variation. One case is very shallow, and shows complete absence of both

The summary of the cases is shown in the following table:

TABLE SHOWING AVERAGE AGE, HEIGHT, WEIGHT AND MEASUREMENT OF THE SELLA TURCICA AND CRANIUM ARRANGED ACCORDING TO NINE CLASSES.

Class	Age	Height Inches	Weight Pounds	Sella Turcica Horizontal mm.	Sella Turcica Vertical mm.	Longitudinal mm.	Vertical mm.	Sex		No. of Cases
I	26	65	143	11	8.1	198	138	1 M	6 F	7
II	34	65	134	9.6	7.6	191	135	7 M	13 F	20
III	31	65	141	10.2	7.3	192	138	1 M	5 F	6
IV	36	67	161	10.6	7.5	193	139	4 M	3 F	7
V	45	65	151	9.9	7.	194	137	6 M	3 F	9
VI	26	65	134	9.	6.	189	142	3 M	7 F	10
VII	31	64	193	9.2	6.4	183	138	3 M	10 F	13
VIII	30	65	129	10.6	7.6	191	137	5 M	14 F	19
IX	36	64	131	9.5	6.2	190	134	2 M	7 F	9
Average	32	65	146	9.9	7.2	192	137	32 M	68 F	100

CONCLUSIONS

Results based on the study of one hundred normal cases would indicate that there is an extremely wide range of variation both in regard to size and structure of the sella turcica.

Absence of the anterior clinoid processes, or of both processes, is not necessarily of any pathological significance.

Group I, which showed the longest diameters of the sella, showed also the longest antero-posterior diameter of the head. The smallest heads occurred in this group, and it also showed the greatest variation in structure.

The small, bridged-over sella was found associated with the shortest antero-posterior diameter, and the longest vertical diameter of the cranium. There were a surprisingly large number of completely bridged over cases.

No definite relation between weight, height and age, and size or formation of the sella turcica was observed, except that Group VII showed the highest average age associated with very indistinct processes.

Unusual conditions of the sella should be closely correlated with other clinical data before coming to any conclusion.

Teleroentgenography combined with stereoscopic studies offers the best method of investigation.

THE LEUCOCYTIC BLOOD CONTENT OF THOSE HANDLING RADIUM FOR THERAPEUTIC PURPOSES

By J. C. MOTTRAN, M.B., and J. R. CLARKE

[From the *Proceedings of the Royal Society of Medicine,* London, Vol. XIII, No. 3, January, 1920. Abstract by L. S. Goin.]

This is a study of the effect of radium on the blood count of those employed in the Radium Institute of London. Two classes of workers were studied: (A) Laboratory workers who prepare and measure applicators containing emanation and radium; and (B) clinical workers who attach various screens to the applicators and apply them to patients. The leucocyte count of twenty of these individuals was compared with thirty-eight normal people. The polymorpho-nuclear and lymphocyte count is decidedly lower than normal. Eleven individuals had polymorpho-nuclear counts below the lowest normal, and three had lymphocyte counts well below normal. The lowest figures were 522 polymorpho-nuclear and 706 lymphocytes, the next lowest were 1035 polymorpho-nuclear and 855 lymphocyte. There was no evidence of a leucocytosis among the less irradiated workers, the highest count falling about the middle of the normal series. The leucopenia of radium workers manifests itself after a few weeks' exposure. A class A individual showed a drop from 7283 to 3077 polymorphs, and from 4544 to 1612 lymphocytes after one month. A class B worker showed a drop from 4448 to 2398 and 1824 to 1690 after two weeks. A two months' holiday was followed by a sharp rise in the cell count. The onset of the fall is rapid, recovery is slow. It is chiefly gamma rays which affect the worker.

The writers' experiments indicate that class B workers receive about 1.4 per cent of the total radiation received by a patient undergoing treatment for carcinoma of the breast.

UNUSUAL GASTRIC POLYP*

By HOWARD E. RUGGLES, M.D.

Asst. Clinical Professor of Roentgenology, University of California Medical School

SAN FRANCISCO, CALIF.

THERE is a small but growing literature on gastric polyposis, which testifies to its comparative rarity and the importance of the roentgen examination in its diagnosis.

Practically all of the case reports have dealt with the true polypoid form. Menetrier, in a thorough study of the subject in 1888, called attention to a form of polyposis which he named "en nappe." It is a hyperplasia involving a localized area of the mucous membrane which is increased from two to five times its normal thickness, forming a large plaque of soft consistency. The growth is cut up by folds running in all directions. When palpated through the gastric wall, it gives the impression of a bundle of worms. The process is quite rare, only four cases having been reported since Menetrier's article.

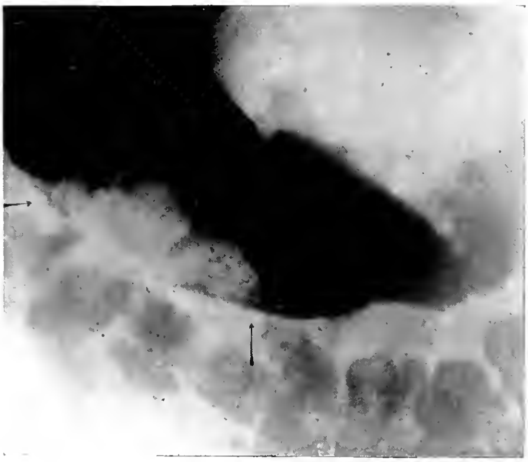


FIG. 1. Prone Position.

Our case was a man of forty-eight complaining of fullness, gas, pressure in the upper epigastrium, belching, and constipation for the past eight months. There was never any severe pain. The sense of pressure was worse before meals and disappeared for an hour after eating, and he never vomited in spite of efforts to do so. He lost thirty pounds during this time. Physical examination was negative. Gastric analysis showed a low acidity. Blood was constantly present in the stomach contents and stools. There was a slight secondary anemia.

The roentgen examination showed a defect along the greater curvature, with a break in the gastric wall involving a quarter of its extent, giving the appearance of a somewhat lobulated mass. It was constant in all positions. Peristaltic waves did not pass through this area. There was no gastric residue at six hours, or other evidence of pathology in the gastrointestinal tract. Operation showed a mass in the middle third of the stomach of which the following is the pathologist's report:

"Specimen shows a tumor mass measuring about 10 x 11 cm. on the stomach mucosa. The surface shows close papillomatous growths resembling brain cortex which has been thrown into folds. In the gross there can be traced a gradual increase from the normal mucosa to the pronounced papillomatous outgrowths. No gross evidence of necrosis can be made out in any of the papillomata, although here and there can be found a slight amount of hemorrhage in the tips.

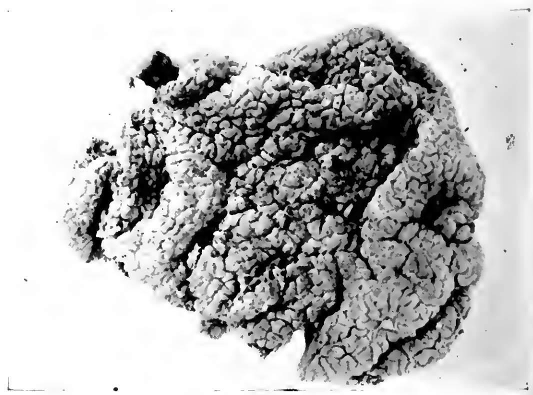


FIG. 2. Mass Removed.

*Read before the PACIFIC COAST ROENTGEN RAY SOCIETY, December, 1917.

"*Microscopical Pathology:* Section shows a picture of stomach mucosa which displays a gradual increase from normal thickness to tremendous hypertrophy, taking upon itself a papillomatous formation. There is an enormous increase in number and length of gastric glands, which show a marked corkscrew type of growth and many branchings. Cells lining the glands are normal in appearance. In no place is there the slightest evidence of the stroma or musculature being invaded by epithelial cells. The basement membrane is everywhere intact and well preserved."

The case is of interest from its resemblance to carcinoma both clinically and roentgenologically.

BIBLIOGRAPHY

MENETRIER. *Arch. de Physiol.*, 1888, p. 32.

MYER, J. S. Polyposis Gastrica. *J. Am. M. Assn.*, Vol. 61, p. 1960, Nov. 29, 1913.

WEGELE. Polyposis of Stomach. *J. Am. M. Assn.*, Vol. 51, p. 448, Aug. 1, 1908.

WINTERNITZ and BOGGS. Multiple Polypi of Stomach. *Johns Hopkins Hosp. Bull.*, Vol. 21, July, 1910.

CAMPBELL. Tumors of the Stomach. *Surg., Gynec. & Obst.*, Vol. 20, p. 66-71, 1915.

BASCH. Primary Benign Growths of the Stomach. *Surg., Gynec. & Obst.*, Vol. 22, p. 165-170, 1916.

FINNEY and FRIEDENWALD. *Am. J. M. Sc.*, Vol. 154, p. 683, Nov., 1917.

BALFOUR. Polyposis of Stomach. *Surg., Gynec. & Obst.*, Vol. 28, p. 465, May, 1919.

LEDDERHOSE, G. *Deutsche Med. Wchnschr.*, Vol. XLVIII, No. 48, p. 2239, Nov. 27, 1914.

HEINZ, H. *Beitr. zur klin. Chir., Tübing.* Vol. XCIII, No. 2, p. 228.

A WORD TO THE ROENTGEN THERAPEUTIST

BY C. AUGUSTUS SIMPSON

WASHINGTON, D. C.

I HOPE that those who have been and are using the roentgen rays for the treatment of hyperthyroidism are alive to the recent literature on the metabolic studies in this disease.

We have waited for years for a test that would show the actual improvement or lack of improvement in patients with Graves' disease following surgical and *x*-ray treatment. We have it now in the metabolism tests which have been perfected and popularized by pathologists and internists.

These tests show what I have been writing for the past six years, namely, that massive measured doses of *x*-rays over the thyroid and thymus glands at three week intervals will cure 90 per cent of the cases of hyperthyroidism and in the very great majority of instances render an operation unnecessary.

At last we have been able to demonstrate three things to which every roentgen therapeutist should be thoroughly alive and of which they should take immediate advantage:

1. That animal experiments show the *x*-ray will completely atrophy the thyroid as well as the thymus gland.

2. That raying of the thyroid gland does not complicate a future operation, but on the contrary serves to lessen the danger and risk to the patient.

3. That according to the metabolism tests carried out at the Massachusetts General Hospital, and other medical centers, the *x*-ray offers a very much better and decidedly less dangerous method of treating hyperthyroidism than surgery.

In comparing the two methods of treatment, not only was the raying without the danger of an operation and the results years later quite as good, but the patients who were treated by the roentgen ray to begin with were 27 per cent more toxic or dangerous than those operated on.

These results to my mind are a distinct victory and achievement for the *x*-rays, and obtained as they were by disinterested pathologists and internists, should show the profession at large what splendid results the

roentgen ray will give in Graves' disease. In a series of over one hundred cases, extending over a period of six years, I have had some failures, but also I have many who have been operated on, some as often as three times, with a return of the tumor and of all the symptoms.

I am quite sure the time will soon arrive when surgery will be considered only in the small percentage of cases of hyperthyroidism which fail to respond to the roentgen ray. As a matter of fact, a failure from *x*-ray will most often prognosticate an operative failure.

I can truthfully say that a physician makes a grave and deplorable mistake if he allows his patient to be operated on before getting massive doses of *x*-ray over the thyroid and thymus glands.

Give the patient an honest opinion as to the relative value of the roentgen ray and surgery, and that patient will invariably select the *x*-ray. Once they have had the *x*-rays properly administered, there will be very few instances where there is any need for an operation.

Now it is for every roentgen therapeutist to take an active interest in this splendid advance in theraphy, improve his technique, and see that patients are not exposed to a dangerous and disfiguring operation, when he has means at hand to prevent it.

I am satisfied that the three contradictory papers read in four years by a young roentgen therapeutist representing a great medical school and hospital, each paper and discussion expressing diametrically opposite views to its prior article on the above subject, must have been due to the influence of a surgical department over the *x*-ray department of his institution. At least I shall be charitable and say that he meant well.

In conclusion, let me say that if the roentgen therapeutist studies his patients, and carries out his technique accurately, he will not only obtain splendid results but he will actually save many lives and gain the undying thanks of scores of patients.

TWENTY-FIRST ANNUAL MEETING

FURTHER SUGGESTIONS ABOUT TRIP

TICKETING arrangements and railroad fares are essential items in connection with any trip, and especially so in connection with the journey to Rochester and Minneapolis for our Twenty-first Annual Meeting, September 14th to 17th, inclusive. The following information is, therefore, offered as first aid.

Do not fail to buy a round trip summer tourist excursion ticket, reading "via Chicago Great Western Railroad" between Chicago and Twin Cities. No other ticket to Twin Cities or beyond, and no other route, will permit of the stop-over at Rochester we have incorporated in our programme.

Summer tourist tickets are on sale to Twin Cities from almost all territory, the exceptions being the Trunk line and New England States, that is, the territory east of Buffalo and Salamanca, N. Y., Pittsburgh, Pa., and Wheeling, W. Va., and north of the Chesapeake & Ohio line.

From this portion of the country it will be necessary, in order to secure the stop-over privileges previously mentioned, to buy a summer tourist ticket to some destination beyond Twin Cities. From the New England territory, the first point beyond is Buffalo, Minn., only a short distance west of Minneapolis. From New York, Pennsylvania and the East, Sauk Center, Minn., is the nearest available destination, unless it is more convenient to purchase a one way ticket to Buffalo or Salamanca, N. Y., Pittsburgh, Pa., or Wheeling, W. Va., and from there buy round trip summer tourist excursion ticket to Twin Cities or beyond as outlined herein.

These ticket suggestions are addressed to those who must return home as quickly as possible, and it will be well to bear in mind that it is not necessary to use the ticket beyond Minneapolis when such tickets are purchased. To our other members, we again call to their attention the unusual opportunity that is offered to combine pleasure with business. Minneapolis is at the threshold of the truly wonderful Lake country of Minnesota. Within the area covered by St. Paul and Minneapolis are no less than thirteen lakes, and only a short car-ride away is beautiful Lake Minnetonka with its innumerable bays and inlets. But these are only a very few of the very many; a glance at that portion of the map of Minnesota lying north and northwest of Minneapolis will show lakes without number. These lakes abound in the fish that delight the angler—bass, pike, pickerel, and the mighty muskellunge. Hotel accommodations are excellent, an essential to the thorough and proper enjoyment of a vacation. Bathing, boating, golf and tennis furnish additional recreation, all calculated to further the complete enjoyment of the wonderful Minnesota atmosphere. We are indeed fortunate that our meeting affords this splendid opportunity to visit such a fine vacation country. There are numerous Minnesota points authorized as destinations for summer tourist excursion tickets, and if you will write Mr. A. C. Irons, General Passenger Agent, Chicago Great Western R. R., Chicago, Ill., advising him just what plans you are considering for your trip, he will gladly give you such information as will best meet with your requirements. Inquiry should be made early so that details may be arranged in time.

THE AMERICAN JOURNAL OF ROENTGENOLOGY

PUBLISHED BY PAUL B. HOEBER, NEW YORK CITY

Issued Monthly. Subscription, $6.00 per year. Advertising rates submitted on application. Editorial office, 480 Park Av., New York. Office of publication, 67-69 East 59th St., New York.

TWENTY-FIRST ANNUAL MEETING

The Twenty-first Annual Meeting of THE AMERICAN ROENTGEN RAY SOCIETY will be held at Rochester, Minn., and Minneapolis, Minn., September 14, 15, 16 and 17, 1920; at Rochester on the 14th, at Minneapolis on the 15th, 16th and 17th. Further details concerning the meeting will appear in these columns from month to month.

Meeting and exhibits will be held in the CURTIS HOTEL, Minneapolis, which can accommodate about 300 members and guests. Reservations should be made early.

For information regarding railroads and method of travel, address Mr. A. C. Irons, General Passenger Agent, Chicago Great Western R. R., Chicago, Ill.

TWENTY-FIRST ANNUAL MEETING PRELIMINARY PROGRAM

The Preliminary Program for the meeting of THE AMERICAN ROENTGEN RAY SOCIETY, Rochester, Minn., September 14, 1920, Minneapolis, September 15, 16 and 17, 1920, is as follows:

Tuesday, September 14, 1920

6:45 A. M. Arrive Rochester, via Chicago Great Western Railway.

7:00 A. M. Breakfast, Congregational Church, corner Second Street and Second Avenue, S. W.

8:00 A. M. to 12:00 noon. Surgical Clinics.

St. Mary's Hospital:

Operating Room 1.—Dr. C. H. Mayo.
Operating Room 2.—Dr. W. J. Mayo.
Operating Room 3.—Drs. E. S. Judd and V. C. Hunt.
Operating Room 4.—Drs. D. C. Balfour and J. C. Masson.
Operating Room 5.—Drs. W. E. Sistrunk and C. A. Hedblom.
Operating Room 6.—Drs. J. D. Pemberton and A. W. Adson.

Colonial Hospital:

Orthopedic surgery.—Drs. M. S. Henderson and H. W. Meyerding.
Thoracic surgery.—Dr. C. A. Hedblom.

Worrell Hospital:

Oral surgery.—Dr. G. B. New.
Surgery of Ear, Nose and Throat.—Drs. H. I. Lillie and R. A. Barlow.
Dental surgery.—Drs. B. S. Bardner and L. T. Austin.

The Doctors Mayo have promised that so far as possible, the surgical material for the clinics of September 14th will consist of cases of special interest to roentgenologists, the other classes of surgical cases being arranged for the day before or the day after.

9:00 A. M. to 11:00 A. M.

St. Mary's Hospital:

Pathological demonstration.—Dr. William C. MacCarty.

Demonstration of Gross Pathology.—Dr. H. E. Robertson.

Radium Hospital:

Radium and Roentgen Therapy Clinic.—Dr. H. H. Bowing.

The number of visitors in all clinics and demonstrations will necessarily be limited; allotments for the morning will be arranged immediately after breakfast.

12:00 to 1:00 P. M. Tour of the Mayo Clinic Building in small personally conducted parties.

1:00 P. M. Luncheon at Congregational Church.

2:00 P. M. Presentation of papers by the members of the Mayo Clinic Staff, Congregational Church, corner of Second Street and Second Avenue, S. W.

Dr. W. J. Mayo, Address of Welcome: *The Relation of Roentgenology to Surgery.*

Dr. M. S. Henderson: *Roentgenology in Bone Diseases.*

Dr. W. F. Braasch: *Pyeloroentgenography.*

Dr. R. D. Carman: *Roentgenology in the Mayo Clinic.*

Dr. W. C. MacCarty: *A Comparison of Roentgenologic Pathologic Findings in Gastrointestinal Lesions.*

Dr. H. H. Bowing: *Radiumtherapy in the Mayo Clinic.*

Dr. B. S. Gardner: *Roentgenology in Dental Diseases.*

Dr. L. B. Wilson: *Graduate Education in Roentgenology.*

5:00 P. M. Leave for Minneapolis by special train via Chicago Great Western Railway.

The following papers have been promised for the Minneapolis Program.

Dr. W. T. Bovie: *A Rational Basis for Sensitometry* (Read by Invitation).

Dr. F. W. O'Brien: *A Rational Method of Sensitometry.*

Dr. R. B. Wilsey: *The Influence of Scattered X-Rays in Radiography* (Read by Invitation).

Dr. A. W. Pirie: *A Retinometer, an Instrument for Measuring the Degree of Sensitiveness to Light of the Retina, to be Used in Connection with Fluoroscopy.*

Dr. W. D. Coolidge: *Physical Investigation Work in Progress on Tubes and Accessories.*

Dr. Walter C. Alvarez: *The Use of CO_2 in Producing Pneumoperitoneum* (Read by Invitation).

Dr. Albert F. Tyler: *Pneumoperitoneum as an Aid in the Differential Diagnosis of Diseases of the Left Half of the Abdomen.*

Dr. W. H. Stewart: *A Revised Estimate of the Value of Pneumoperitoneum.*

Dr. I. C. Rubin: *Pneumoperitoneum with Special Reference to Sterility and Allied Gynecological Conditions.*

Dr. L. T. LeWald: *Leather-Bottle Stomach: Report of a case together with its differential diagnosis from syphilis and carcinoma of the stomach.*

Dr. Lawrence Reynolds: *Some Observations of the Physiology of the Duodenum as Determined by the Fluoroscope* (Read by Invitation).

Dr. A. W. George: Title not announced.

Dr. G. E. Pfahler: *New Roentgenographic Technique for the Study of the Thyroid.*

Dr. Kennon Dunham: *A Review of X-Ray Chest Examinations.*

Dr. D. C. Jarvis: Title not announced.

Dr. W. W. Watkins: *Syphilitic-Tuberculous Symbiosis in the Lungs, reviewing the characteristics of each infection and of the double infection.*

Dr. R. J. Allison: Title not announced. (Read by Invitation.)

Dr. A. C. Christie: Paper on *Intrathoracic Neoplasms.*

Dr. E. H. Skinner: *The Collateral Treatment of Malignant Patients Undergoing Radiotherapy.*
Dr. Samuel Stern: Title not announced.
Dr. Isaac Levin: Title not announced. (Read by Invitation.)
Dr. R. H. Boggs: Title not announced.
Dr. John T. Murphy: *Calcified Cyst of Brain.*
Dr. Preston M. Hickey: *Paper on Mastoids.*
Dr. Hollis E. Potter: *The Use of the Bucky Diaphragm in Spine Examinations.*

As special guests of the Society, we will have, in addition to Dr. Bovie, Dr. Dallas B. Phemister of Chicago, *Studies on the Reduction of Bone Density*, Dr. Robert Knox of London, England, well known to all roentgenologists, Dr. Gonzales Martinez, of Paris and Porto Rico, who will present a paper on some phases of heart disease, and Dr. Walter C. Alvarez of the University of California, who will give the Caldwell Lecture on *Peristalsis in Health and Disease.*

Several other papers have been promised by Dr. Walter C. Hill who is now in Europe and will give a report on recent observations in Europe, and Dr. Leopold Jaches, who will give a sketch of the *x*-ray progress in Germany since the beginning of the Great War. Dr. Frederick M. Law will also exhibit a series of moving pictures.

It has been the intention of the Program Committee to omit no one who has new or important communications. Any one whose name does not appear in the above list who wishes to present a communication to the Society at this meeting will please address the President.

The local Entertainment Committee, consisting of Drs. C. D. Harrington, S. R. Maxeiner, C. A. Donaldson, R. R. Knight, Stanley Kerrick, Allison, F. S. Bissell, F. J. Souba, K. Ikeda, E. L. Gardener, S. Marx White and Charles A. Reed, have arranged an extensive plan for entertainment of the visiting members and guests. The present plan is to have Wednesday evening for lantern slide night, Thursday late afternoon and evening for an automobile ride, and a dinner dance at one of the country clubs; Friday night will be a banquet at the Hotel Curtis for which an interesting program has been provided.

Ample space has been provided for the Scientific Exhibit and all members are urged to bring with them material for this exhibit. Those contemplating presentation of plates should communicate with Dr. F. S. Bissell, Chairman of the Scientific Exhibit Committee, 801 La Salle Building, Minneapolis, Minnesota, as soon as possible, in order that ample provision may be made for exhibit racks.

Those wishing to demonstrate lantern slides will please communicate with the President, Dr. James T. Case, Sanitarium, Battle Creek, Michigan. Please give the number of slides it is desired to show and if possible, the topic covered. The program for the lantern slide night will be arranged for in order of application.

THE AMERICAN RADIUM SOCIETY FIFTH ANNUAL MEETING

The Fifth Annual Meeting of The American Radium Society was held in New Orleans, La., April 26, 1920, Dr. Henry K. Pancoast presiding. The following program was presented:

Economic Problems of Radium Therapy. Dr. Albert Soiland, Los Angeles, Cal.

Radium in Toxic Goiter (read by title). Dr. W. H. B. Aikens, Toronto, Can.

The Absorption of Radium Radiation by the Tissues. Dr. G. Failla, New York City.

Report on the Intravenous Injection of the Active Deposit of Radium. Dr. Douglas Quick, New York City.

Symposium Upon Uterine Disease

The Treatment of Fibroids and the Metropathies by Radium. Dr. C. Jeff. Miller, New Orleans, La.

Review of 600 Cases of Menorrhagia and Uterine Myomas. Dr. Leda J. Stacy, Rochester, Minn.

Combined Radium and Roentgen Therapy of Uterine Cancer. Dr. E. H. Skinner, Kansas City, Mo.

The Classification of Uterine Cancer Cases for the Study of the Efficacy of Radium and Roentgen Therapy. Dr. Henry Schmitz, Chicago, Ill.

Discussion was opened by Dr. S. M. D. Clark, Dr. William Kohlmann, Dr. Walter A. Weed and Dr. Rudolph Matas.

Radium in the Treatment of Angiomata. Dr. William S. Newcomet, Philadelphia, Pa.

Discussion was opened by Dr. Ernest C. Samuel.

Symposium Upon the Use of Radium in Malignancy

Use of Emanation in the Treatment of Malignant Tumors (read by title). Dr. H. H. Janeway, New York City.

The Treatment of Recurrent and Metastatic Carcinoma of the Breast. Dr. Geo. E. Pfahler, Philadelphia, Pa.

Discussion was opened by Dr. T. C. Kennedy and Dr. R. E. Loucks.

A banquet was held in the evening when Dr. John M. Lee gave a demonstration. The following officers were elected:

President
Henry Schmitz, M.D., Chicago, Ill.

First Vice-President
Henry H. Janeway, M.D., New York

Second Vice-President
Leda J. Stacy, M.D., Rochester, Minn.

Treasurer
R. E. Loucks, M.D., Detroit, Mich.

Secretary
William S. Newcomet, M.D., Philadelphia, Pa.

Member of Executive Committee
Henry K. Pancoast, M.D., Philadelphia, Pa.

The American Journal of Roentgenology was made the official organ of the Society.

CORRESPONDENCE

Shanghai General Hospital,
June 5th, 1920.

Dr. Edward C. Titus
127 West 11th St.
New York City

Dear Dr. Titus:

You told me to call on you if ever I needed help, so here I am. The Governors of the Hospital have instructed me to make inquiries as to the possibilities of securing an expert radiographer either from England or America, and I naturally turn to you to help us in this matter.

Dr. Macleod, who has been one of the leading doctors of Shanghai for well on to 50 years and who organized and has been in charge of our *X*-ray Department since its inception, has after many years of hard work for the Hospital given it all up and now acts only as Consultant. * * * The Governors have decided to take up the question of a really competent man to carry on this work.

There are some half dozen *x*-ray plants in Shanghai, but unfortunately there are none, since Dr. Macleod's resignation, which have an expert in charge. Under the wise and scientific direction of Dr. Macleod this Hospital has always been well in the vanguard as concerns this department, and as we have the best equipment it is our desire to secure a man who shall be able to carry on the splendid work done here hitherto. This means that we want a man who has had experience in all phases of *x*-ray work. He will be furnished with necessary assistants, but it is well that he knows the business from the ground up.

The entire time of the man in question would be at the disposal of the Governors of the Hospital, and as the *x*-ray work at present would not occupy him fully he would be expected to assume other professional duties, say electro-therapeutic or such other work as might be decided upon after his arrival.

It is usual that a five years' contract be entered into, to be terminated by either party on six months' notice. The man should be in

such physical condition as to enable him to pass as a first-class risk with a good insurance company. * * * We have no idea what a first-class man (and we want no other) would expect in the way of salary, so we will have to wait until we hear from you or him before making a definite offer. If in your answer you are able to give us information as to some one who is willing to come out, if we can meet his expectations as to salary, etc., it would be more satisfactory, as we could then close the matter by cable.

I trust I am not making too big a demand upon you and would like to assure you that anything you may be able to do for us will be greatly appreciated.

Yours sincerely,
(Signed) J. B. Fearn,
Secretary.

COMMUNICATION

From Dr. Med. K. Secher
Municipal Hospital
COPENHAGEN, DENMARK

To the Editor of The American Journal of Roentgenology:

It is not necessary in this Journal to point out the importance of roentgen therapy as applied to the treatment of exophthalmic goiter. Since the x-rays were introduced into the therapy of this disease in 1905, a series of roentgen treated cases have been published in all countries, and it is thus beyond doubt that this treatment of the disease in question is one of the most important—a view to which I can fully subscribe. It is, therefore, to say the least, unfair, when in discussing a paper of mine in this Journal, 1919, page 49, Dr. H. K. Pancoast and Dr. Russell H. Boggs declare that I am opposing it, in that they only know my article from an evidently incomplete abstract, a fact which renders their criticism still less excusable.

Our knowledge of the effect of x-rays on the thyroid gland has not, however, increased very much during the years passed since 1905. In reality, we are on the same empiric basis now as at the introduction of this therapy. It is, therefore, quite unreasonable to declare that my work "loudly proclaims lack of knowledge of the physiological action of roentgen rays, especially as applied to the treatment of exophthalmic goiter."

In reality, the x-ray treatment of exophthalmic goiter is a subject still open to discussion, as it presents various problems which have not yet been solved and are claiming constant attention. As far as several other diseases are concerned, the effect of roentgen therapy is so well understood that the ncessary dose can now be stated exactly, but this is not the case with the thyroid gland and especially not with that pathological state which constitutes exophthalmic goiter. Complications may here always be met with on account of a too strong reaction on the part of the gland.

Roentgen treatment of the thyroid gland may cause a hypofunction of the organ, an effect which, however, seems to be of rare occurrence, and so shall not be dealt with here. But it may also give rise to a hyperfunction, a fact which renders difficult the estimation of a perhaps too strong dose, when the treatment is applied in a disease as exophthalmic goiter which itself depends upon a hyperfunction of the gland. On the other hand, the roentgen treatment has been used successfully in cases of severe hyperthyroidism (Simon, *Deutsche med. Wochenschrift,* 1911, p. 1345), which illustrates the difficulty of explaining the physiological effect of the treatment.

It is well known that the hyperthyroidism which immediately follows roentgen treatment is of common occurrence and—as may be seen from the literature—many authors reckon with it as a reaction which proves the efficacy of the rays.

Belot (*Strahlentherapie,* 1913, p. 561) states that the first few days after the treatment many patients, especially women, complain of indisposition, headache, diarrhea and vomiting, and therefore advises giving fractional doses. According to other authors

this does not seem to occur quite so constantly. Fischer (*Ugeskrift for Läger,* 1916, p. 1755) writes: "On the contrary, I have every now and then seen that patients who later on improved, felt worse after the first treatment, and I have ascribed this to the effects of an increased glandular secretion, the glands having as a rule at this point of time started to diminish in size."

Although the hyperthyroidism due to the roentgen treatment is of no special consequence in the great majority of cases, several authors report cases in which immediately following *x*-ray treatment serious conditions have occurred presenting the picture of a hyperthyroidism. This refers to the cases by Zimmern and Raymond, 1905, Stens-Hess, 1907, Faber, 1908, Kracke, 1909, Michailow, 1910, Stoney, 1912, and many others, and so to cases so recently observed that they cannot be attributed to a wrong technique.

It is on the base of these cases that those of Verning, Rieder, and that of this paper ought to be considered, in all of which death occurred after the roentgen treatment of exophthalmic goiter. The particulars of Rieder's case are, however, so imperfect that it is impossible to form a positive opinion of it. In Verning's and in my case the course of the disease cannot preclude the possibility that death was due to a hyperthyroidism caused by *x*-ray treatment.

The patient in Verning's case (*Hospitalstidende,* 1917, p. 731), was a woman aged twenty-six, who suffered from a severe Morbus Basedowii which remained unchanged during the first month of her stay at the hospital, loss of weight not noted. The pulse kept about 110-120. Her subjective feeling of heart-beat disappeared by and by during her stay at the hospital; the appetite was constantly bad. A month after her admission she had two roentgen treatments two days in succession, each of five hours, with filtered rays (3 mm. aluminum).

For the first three to four days after the treatment her condition remained unchanged, but later on the picture of a strong hyperthyroidism developed, which caused death two weeks after the *x*-ray treatments. Autopsy was not performed. (Verning furthermore has mentioned another case, in which, however, the casual relation seems more doubtful.)

In my case the patient was a woman aged forty, who had been suffering for a year, and was admitted to the hospital with an advanced Morbus Basedowii with the following symptoms: Exophthalmic goiter, Gräfe's, Möbius' and Stellwag's signs, and a considerable enlargement of the thyroid gland. Her heart was not enlarged, her pulse was about 100. A month after her admission she was subjected to *x*-ray treatment throughout a week. The treatment was supervised by the Roentgen Clinic (Chief: Professor Fischer). She had eight treatments à ½ Sabouraud-Noiré, with two mm. aluminum filters on four areas, three on the thyroid gland and one on the thymus. Already during the first treatment she became restless, confused, and had choreiform movements. Her restlessness increased, her pulse went to more than 200, respiration 72, until death occurred. At the autopsy the weight of the thyroid gland was found to be 145 gr., its width 9 cm. and its height 8 cm. No beginning degeneration was noted. The heart was not enlarged, it weighed 300 gr.

The criticism of Dr. Pancoast and Dr. Boggs is based upon ignorance of the nature of my case, otherwise they would not write: "It is most likely that Secher's cases were unrecognized exophthalmic types and not simple goiter." It decidedly was not simple goiter, but a typically developed case of exophthalmic goiter in which signs of a hyperthyroidism may be expected after roentgen treatment, a fact which my critics admit that roentgenologists acknowledge. It is the more unreasonable to believe my case to be only a simple goiter as, according to the unanimous opinion of roentgenologists, these cases are hardly ever fit for *x*-ray treatment, as usually they will remain unaffected by the rays. In some cases a simple

goiter has even developed into an exophthalmic goiter after the roentgen treatment (v. Decastello, L. Freund, Chwostek.)

In discussing the cause of death in Verning's case and in mine there are also two possibilities: The patient may *either* have died from a hyperthyroidism, caused directly by the roentgen treatment, *or* from a hyperthyroidism, due to a propagation of the disease itself, so that the *x*-ray treatment and the hyperthyroidism may only accidently have occurred at the same time. A definite solution of this question cannot be obtained on the basis of the material now placed before us. A mere supposition as to the causal relation between the roentgen treatment and the hyperthyroidism is all that can be expressed. This is what I have said, nothing else and nothing more. But acknowledging that symptoms of hyperthyroidism have occurred in several cases after roentgen treatment of exophthalmic goiter, and that serious conditions have developed in some cases, it is only a short step to admit the possibility that the *x*-rays may cause death in very roentgen-sensitive cases, even if the treatment be administered properly.

The lethal form of hyperthyroidism in exophthalmic goiter frequently presents the picture of a psychosis, which may be accompanied by restlessness, mania or melancholia. These conditions have been known since the first description of the disease, and were also mentioned by Basedow.

Both in Verning's and my case pronounced restlessness was observed before death occurred.

In the department for the insane of this hospital, patients suffering from exophthalmic goiter are treated every now and then, being removed to this ward on account of their psychosis-like condition.

Incidentally, just in the last few days two patients have died whose cases may throw some light upon the question under discussion.

One patient was a woman aged thirty-six, who had been suffering for two to three months from an incipient exophthalmic goiter with strongly pronounced exophthalmus, Möbius' sign, large struma, pulse 136. At the time of her admission to the hospital she was very restless, crying. She died four days after admission, with increasing restlessness and confusion. She had no roentgen treatment.

The other patient was a man aged thirty-five, who had been suffering for four months before his admission to Finsen's Clinic. His pulse was 150, he was very nervous, had tremor, enlargement of the thyroid gland, but no eye symptoms. A few days after his admission he had a roentgen treatment. The following day he became very restless and somewhat confused. He was removed to the department for the insane and died a few days later on, with increasing restlessness, confusion and pulse over 200.

We have thus two patients who died, both presenting the picture of the psychosis caused by hyperthyroidism. One of these patients had roentgen treatment, but only so small a dose (1 S.N. for thirteen minutes with 3 mm. filter) as to render the conclusion justified that the *x*-ray treatment itself cannot have caused death. If the patient had been subjected to a stronger dose, it might have been supposed that the treatment had been the direct cause of the lethal hyperthyroidism. There is, however, the difference between this case and those observed by Verning and myself, that the *psychosis-like condition* here sets in the day after the treatment, while in the two last-mentioned cases it began later on, namely at a point of time at which, on the whole, the reactive hyperthyroidism may be expected; and it is also at this point of time that the serious conditions have occurred in the cases mentioned above.

Both in Verning's and in my case, the patients had been subjected to roentgen doses strong enough to have influenced the gland. For this reason I feel entitled to express myself as I did before, and the last mentioned case illustrates the necessity of reservation towards the whole question. But these cases will distinctly reveal the problem still

open to discussion and claiming the attention of roentgenologists. We do not get any farther by avoiding the whole question, as did Dr. Pancoast and Dr. Boggs, and especially not by founding a criticism upon so insufficient a basis as was done by them in their discussion of my paper.

In conclusion I shall only draw attention to the warnings lately given as to the application of the very hard rays, which, according to experience, are able to give rise to such changes in the stomach and the intestines as may convey death. (H. E. Schmidt, *Fortschritte a.d. Gebiet. d. Röntgenstrählen,* Vol. 25, Part 4.)

K. SECHER.

TRANSLATIONS & ABSTRACTS

Cohn, Alfred E., M.D. An Investigation of the Size of the Heart in Soldiers by the Teleroentgen Method. (*Arch. Int. Med.*, Vol. XXV, No. 5, May 15, 1920.)

It is not known with sufficient accuracy whether exertion, such as soldiers undergo in warfare, is accompanied by enlargement of the heart. The present study was undertaken to obtain information on this point. The examinations were made during May, 1919, of soldiers who had seen active service in the American Expeditionary Forces. Infantrymen were chosen, or men who had been subjected to an equivalent amount of privation and exertion. In this report are given the results of the study of the size of the heart only. Physical examinations were made and electrocardiograms were taken. The examinations now reported were roentgenographic. The exposures were made with sternum turned to, and parallel with, the plate. The distance from the anticathode of the roentgen ray tube to the photographic plate was 6 feet. A strip of lead about 1.0 cm. long, 6.0 mm. wide, and about 3.0 mm. thick was laid on the skin over the spines of the vertebrae and secured with adhesive plaster. Two acute angles of lead were similarly secured—one in the suprasternal notch and the other in the infrasternal notch. The target of the roentgen ray tube was adjusted to the level of the lower angle. Whether correct anteroposterior alignment was obtained, could then be ascertained by examining the plate. The exposures were made in the standing position. In making studies of this kind, Bardeen made the exposure "during deep but not forced inspiration and with two half second exposures with an intervening half second so as to insure a diastolic outline." The exposures were made by Smith during an inspiration of moderate depth after the subject had taken a deep breath and expired it. A method involving deeper breathing than normal has this purpose: it frees a larger portion of the cardiac shadow from the shadows of the surrounding viscera, especially the liver, and it permits the drawing of the outline of the cardiac shadow with greater ease. It is admitted that there is a disadvantage in the procedure; when the breath is held too long it occasions too great a filling of the heart, the photograph of which is, in consequence, larger than normal. A modification of the usual technic was, therefore, introduced in this study. No directions for breathing during the exposure were given; then men breathed normally. In order that the phase of respiration in which the plate was secured might be known, the following technic was devised. On the plate holder a lead strip was secured to indicate the neutral position of the vertically hanging lever of a Marey tambour with a lead ring. The tambour was connected by rubber tubing with a Politzer bag held in position in the right axilla by a binder secured by tying its tails; metal fastenings were, of course, avoided. During respiration, the lever swung to one or other side of the neutral line indicated by the lead strip. The side to which the lever swung during expiration was indicated on the plate holder by fastening there a lead letter E. The exposures were brief, a fraction of a second, perhaps as little as one-tenth second on occasion, so that the image of the lead ring of the lever was sharp. When the exposure was longer, or the breathing faster, the trail of the lever, as it swung across the plate, appeared on the plate and showed this fact. The lever of the tambour was in view of the operator, so that by observing it the exposure could be made in any phase of breathing. The desired information was, accordingly, recorded on the plate. The attempt was made to secure the exposures during normal inspiration. This succeeded in 140 of 161 instances. But to study the effect of normal breathing on the size of the heart, the heart in 56 instances was photographed both in inspiration and in expiration. Note should be taken of the fact that in many persons expiration is not an active process, but is the release from inspiration. In these cases, the expiratory phase is represented by the neutral position. There is, however, a defect in this method. It is impossible to record on the plate the exact level of the respiratory phase at which the exposure was made. The method is subjective to the extent that to secure the photograph at the height of the respiratory phases, reliance is placed on the operator. The measurements taken were those recommended by Moritz and his followers. In the plates the right and left borders were traced, and the

outline of the heart's shadow completed by joining arbitrarily the lines representing these. The long and transverse diameters were measured. The angle of inclination of the heart, that is to say, the angle formed by the long diameter and a line drawn to the cardiac apex at right angles with the median line, was recorded. The area of the cardiac outline was measured by the planimeter. In measuring 56 pairs of roentgenograms it was found that in inspiration and in expiration the transverse diameter was identical in 6 pairs, greater in inspiration in 31 pairs and smaller in 19 pairs. The long diameters were identical in 3 pairs, greater in inspiration in 42 pairs, and smaller in 11 pairs. The area was greater in inspiration in 44 pairs, smaller in 12 pairs. The angle of inclination was identical in 3 pairs, greater in inspiration in 39 pairs, and smaller in 14 pairs. But the difference in size and the difference in position was not great. The comparison of roentgenograms made in normal inspiration and expiration then, permits the statement that the difference between the two is not great; that, as is expected, the size of the heart shadow is usually greater in inspiration; and that, in this phase, the angle of inclination is usually larger. For clinical purposes, therefore, as will be shown, in a method accompanied by variations so large, the influence of the phases of normal respiration on the size of the heart may be neglected.

CONCLUSIONS

1. In normal breathing the difference in the size of the heart during inspiration and expiration may be neglected.

2. The use of the transverse diameter of the heart shadow is a satisfactory measurement. It is as useful as and less uncertain than the long diameter of the area.

3. The range of the observed measurements interferes with the usefulness of the clinic of standard and average curves.

4. The hearts of soldiers examined under conditions stated are not larger than those of normal individuals.

W. W. Belden.

Brazsch, W. F., M.D., and Carman, R. D., M.D., Rochester, Minn. Renal Fluoroscopy at the Operating Table. (*J. Am. M. Assn.*, Vol. 73, No. 23, December 6, 1919.)

The apparatus used for making fluoroscopic observations of the kidney at the operating table is essentially the same as that used in the base and field hospitals of the army, but with certain minor changes which make it adaptable to civilian practice. Such instruments (machines) consist of a transformer and autotransformer enclosed in a metal cabinet mounted on large casters for portability. To the cabinet is attached a tube stand with a horizontal arm having universal joints for supporting the tube. The tube is of the Coolidge radiator self-rectifying type, mounted in a lead glass shield. The unit is small and compact, requiring less than 2½ square feet of floor space. It is of light weight, is portable, and has no moving parts which might cause noise and vibration. The current is turned on and off either by a hand or a floor switch. These portable units may be operated from the ordinary lamp socket without special wiring.

Technic. As an essential preliminary, the roentgen ray operator should wear goggles of smoked glass for about fifteen minutes before the observation is to be made in order that he may have the necessary dark-accommodation and retinal perception. The roentgen ray unit should be placed as close to the operating table as possible, and the rays focused through a small diaphragm so that they will pass through the delivered kidney on the fluoroscopic screen. When the fluoroscopist is ready to make the roentgenoscopic examination, the hooded screen held in the left hand is placed over the eyes, and the goggles are removed. The current is turned on by means of a foot switch. In the right hand is held a sterilized metal-tipped rod 18 inches long with which the fluoroscopist accurately points to the stone shadow in the kidney. The exposure is short, requiring little more than a flash. The various details can be arranged so that there is no interference with surgical asepsis.

Riggs, Theodore F., M.D., Pierre, S. D. Diaphragmatic Hernia. (*Ann. Surg.*, Vol. LXXI, No. 3.)

Protrusion of a portion of the abdominal viscera through an opening in the diaphragm,

while by no means unknown, is perhaps more frequent than we realize. According to Giffin, about 650 cases of diaphragmatic hernia had been reported in the literature up to 1912, and eighteen articles on this subject, from the point of view of the radiologist or surgeon, have appeared during the past two years. Since many of the diagnoses have been made only in the autopsy room, and as a number of patients have been operated upon with the hernia unrecognized and unrelieved, it is probable, as Soresi so clearly points out, that many a person is in discomfort to-day because of the failure to recognize the true condition present.

According to the authorities the great majority of diaphragmatic herniae occur to the left of the midline. The case herein reported they believe to have been a true traumatic hernia on the right of the midline.

That the hernia was of traumatic origin they believe. That the opening was to the right of the midline they are certain. That the condition was not an elevation or relaxation of the diaphragm is proved by the definite limits of the opening. That the rupture was not through one of the normal openings in the diaphragm was shown by its position and the fact that no tissues passed through the ring other than the transverse colon and stomach.

Of the presence of a hernial sac or membrane they are sure, although they cannot be certain it was not a false sac developed by the longstanding hernia. However, because the hernia evidently did not reach its maximum size at onset, because there were no adhesions of the viscera in the sac, and because the pillars of the split in the diaphragm were so evidently covered with peritoneum, they feel justified in believing the hernia to have been a true one, namely, contained in a sac formed by the diaphragmatic peritoneum and the diaphragmatic pleura.

If it be true, as seems likely, that the profession is not making as high a percentage of correct diagnoses in diaphragmatic hernia as in other more frequent abdominal conditions, the failure is probably due to lack of a sufficiently definite symptomatology. DeCourcy has formulated a few symptoms which point to non-traumatic cases of diaphragmatic hernia. Soresi discusses fully the difficulties of outlining the symptoms characteristic of small diaphragmatic hernias which he says are never diagnosed, and he urges careful routine examination of the diaphragm. A comparison of the cases reported by Beckman, Giffin, DeCourcy, and others brings out clearly the variations in, and the multiplicity of, the symptoms.

This is to be expected when one considers the many combinations possible, depending upon the location of the hilus and the viscera involved. It is reasonable to expect the traumatic hernia to be more easily diagnosed than the non-traumatic form, but one must remember that the severity of the symptoms is not necessarily in keeping with the size of the hernia. The possibility of a diaphragmatic hernia should, perhaps, be the more often considered.

W. W. Belden.

James T. Case

THE AMERICAN JOURNAL
OF ROENTGENOLOGY

Editor, H. M. Imboden, M.D., New York

VOL. VII (NEW SERIES) AUGUST, 1920 No. 8

A CASE OF INFANTILE SCURVY

By WILLIAM AUGUSTUS NEWELL, M.D.

Assistant Roentgenologist, University Hospital,

PHILADELPHIA, PA.

INFANTILE scurvy, or Barlow's disease, is a constitutional disease of infancy and early childhood. It is similar to the form of scurvy which occurs later in adult life and has only been recognized within comparatively recent times in a sporadic form apart from its occurrence with adult scurvy during epidemics. It was originally recognized by Glisson in 1651 as a separate entity from rickets. Sir Thomas Barlow gave the first comprehensive account of it in a complete description of a series of thirty-one cases in 1883. Since then these investigations have been confirmed by other observers and many cases recorded, notably by J. P. Crozer Griffith.

Scurvy is the result of faulty nutrition due either to a lack of certain proper articles of food or to the feeding of improper articles. Infantile scurvy frequently results from prolonged feeding upon proprietary infant foods, especially those containing dessicated milk in combination with cereals. The incident age of its occurrence is extremely constant, occurring prior to the fourth year of age. Eighty per cent of all cases occur between the sixth and tenth months, and a few beyond the first year of age. In the diseases of infancy and early childhood, rickets, congenital syphilis and scurvy occur in order of frequency mentioned, scurvy and rickets being frequently associated in the same patient.

The pathological changes found are due to increased vascularity and extravasation of blood into the various organs and tissues, the most extensive and important of these changes occurring in the bones, periosteum and muscles. They are most frequent and severe in the lower extremities, where there is a tendency to spontaneous hemorrhages, especially subperiosteal. The femora and tibiae are most commonly affected. These hemorrhages are always accompanied by considerable pain, and bone and joint disease and traumatism may be suspected. The subperiosteal hemorrhages organize with subsequent thickening and increased density of the bones. In young bones the periosteum is thick and very vascular during the period of growth, but becomes thin, less vascular and very adherent to the bone at maturity. In childhood, however, it is but loosely attached to the shaft of the bone from which it is very easily separated. At either end of the bone it is firmly attached near the epiphyseal line, where it becomes continuous with the capsular ligament of the joint. It consists of two layers, an outer fibrous, and an inner cellular layer, the latter being concerned with the growth of new bone. Consequently the subperiosteal hemorrhages in

the bones as in scurvy have a tendency to raise enormous effusions under the periosteum along the shafts of the long bones. These effusions are abruptly limited at the diaphyseal side of the epiphyseal line by the

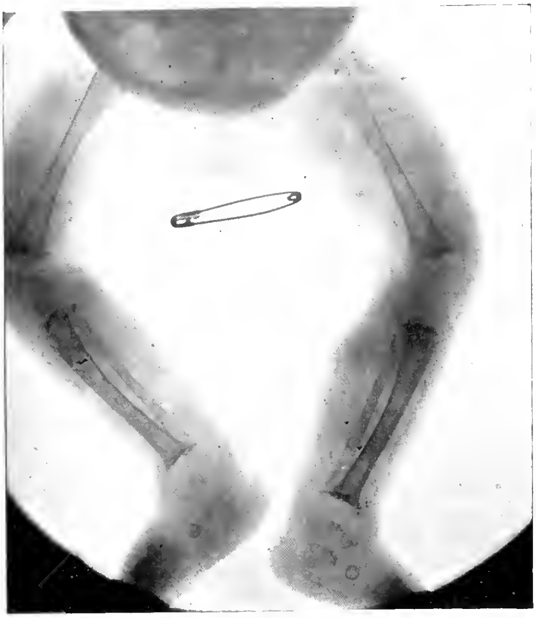


FIG. 1. LOWER EXTREMITIES ON DAY OF ADMISSION, July 14, 1919. Note the line of decreased density just proximal to the lower epiphysis of the right femur, with slightly increased density just distal to the line. The appearance is not so well defined in the other bones. (There was a break in the plate through the lower end of the left femur and the shadow of the break has been touched out.) The appearance at the lower ends of the tibiae and fibulae suggests rickets. Note the absence of any evidence of hemorrhage at this time.

attachment of the periosteum at this site. (Fig. 2.)

The chief clinical manifestations are anemia, lassitude, great weakness, immobility, swelling and tenderness of the extremities. The lesions are usually multiple in respect to the number of limbs involved.

In the roentgen examination for scurvy there are three appearances to be carefully noted. First, the epiphyseal line is usually perfectly normal, but directly behind the epiphyseal line, and according to our observations in the case here reported, at the site of the periosteal attachment, there appears a transverse line of absorption because of the absence of bone structure. This resembles a second epiphyseal line, extending across the entire diaphysis. (Fig. 1. Lower end left femur.) Its appearance during the early

FIG. 2. LOWER EXTREMITIES, NINE DAYS AFTER ADMISSION, July 23, 1919. Note the enormous hourglass shaped subperiosteal hemorrhages extending the entire lengths of the femurs. The effusion at the lower end of the left femur has widened the line of decreased density and apparently pushed the margin of the diaphysis and the epiphysis away from the shaft. This shows the point of attachment of the periosteum at the epiphyseal line.

stages of the disease is that of a line of decreased density due to the absence of bone structure. The edges of the bone structure approximating this line of decreased density are more or less increased in density. The lines of decreased density and increased density are frequently confused in the roentgenologic descriptions of this region. Subsequently a line of condensation representing the area of increased density persists and moves up the shaft as the bone grows. (Figs. 3, 4.) The periosteal hemorrhages stop at the line of decreased density on account of its situation so close to the periosteal attachment. The "white line" of increased density persists during the entire course of the disease, but eventually it disappears after the complete recovery of the patient. The second point to be noted in the examination is periarticular swelling, but

this is of no diagnostic value. The third appearance is the formation of periosteal and frequently subperiosteal hemorrhages, and later calcification within the hemorrhages. After the diagnosis of scurvy has been confirmed, the roentgen examination should be repeated at intervals of a month or more to determine the progress of hemorrhage, absorption and calcification.

An early diagnosis of scurvy by the roentgen ray will often prove to be of the greatest value from both surgical and medical standpoints. In the former the early recognition of scurvy may spare the patient agonizing pain by averting the necessary manipulations in diagnosing cases suspected to be acute bone or joint diseases. It may even avert an operation where the organized hemorrhage simulates a sarcoma, or obviate treatement of a suspected fracture. From a medical standpoint the roentgen diagnosis is also of great importance in that it justifies the physician in administering antiscorbutic treatment immediately, before the onset of any definite clinical evidence of the nature of the disease.

CASE

Baby, male, nine months old, colored. Family history: parents living and well, three healthy children living, three died in infancy. Present illness: Full time baby, always poorly nourished, weighed four pounds at birth. He has been fed on a mixture of a proprietary infant food and whole milk, total quantity per diem, one pint of milk plus one pint of water and five tablespoonfuls of the proprietary food. On the night of July 3, 1919, the mother let the baby sleep on the floor and the next morning she noticed that his right foot and ankle were swollen. This swelling progressed to the hip and then the left leg also became swollen. On admission, July 14, 1919, the baby slept poorly, awakened easily, would not hold up his head nor move his legs. Physical examination: The forehead was moist. He did not use his legs which were tender to the touch. The bones around all the joints were enlarged, especially at the wrists, shoulders, ankles and knees, with swelling of the overlying tissues. The bones of the legs, especially the tibiae, appeared thickened and the legs were tender and edematous. There was no evidence of spina bifida or torticollis. Kernig's sign was absent. The gums did not bleed. The lungs, heart and abdomen were negative. The urine examination was negative. Temperature 101-102. During the physical examination a "rachitic rosary" was detected.

Fig. 3. Lower Extremities Thirty-four Days After Admission, September 16, 1919. Decided calcification of hemorrhages. The line of decreased density has disappeared from the lower end of the right femur, but a line of increased density remains, though it is further from the epiphyseal line through growth of the bone. On the left side the hemorrhage is calcifying beyond the line of decreased density.

Roentgen Findings.—A roentgen examination was made July 14, 1919, on the day of admission, and ten days after the swelling was first noticed by the mother. The request for the examination read, "Examine all long bones of legs for evidences of scurvy or osteomyelitis."

The roentgen report rendered was, "Probable early changes of scurvy." This diagno-

sis was based on the line of decreased density, in the lower portion of the right femur, with increased density distal to it. There was also a suggestion of this appearance in the right tibia, and evidence of some abnormal change was noted in the same locality in the left extremity and at both angles, but the appearance here was not typical and somewhat suggested rickets. There was no evidence of hemorrhage. (Fig. 1.) Thus the first of the three previously mentioned diagnostic appearances was apparent at this initial examination. Instructions were sent with this report requesting that the patient be returned within ten days for further examination, and in the meantime, antiscorbutic treatment was suggested. On the evidence of this roentgen ray examination the antiscorbutic treatment was immediately instituted.

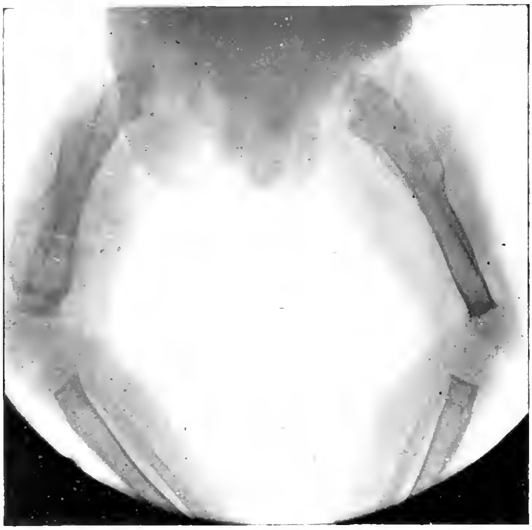


Fig. 4. Lower Extremities, Thirty-seven Days After Admission, showing the knee laterally. The line scarcely shows in the right femur and only the line of increased density shows in the left femur. There is a suspicion of a line of increased density in the upper portion of each tibia. The calcifying hemorrhages have decreased considerably in size by comparison with Fig. 2. The tibiae show slight subperiosteal calcification.

A second examination was made July 23, 1919, nine days after the first, and the report submitted was of "Undoubted scurvy." The roentgenogram showed enormous subperiosteal effusions extending the entire lengths of the shafts of both femurs. (Fig. 2.) The swellings were somewhat hour-glass in shape. The lines of decreased density and the white lines (on plate) of increased density were more apparent. The former one at the lower end of the left femur had widened and pushed the epiphysis away from the shaft. The hemorrhages had stopped abruptly at the lines of absorption. This phenomenon is apparently due to the fact that the periosteum in childhood is loosely attached to the shaft of the bone, but firmly attached at the epiphyseal line; consequently the hemorrhages raise the periosteum very easily but meet with a barrier at the epiphyseal junction.

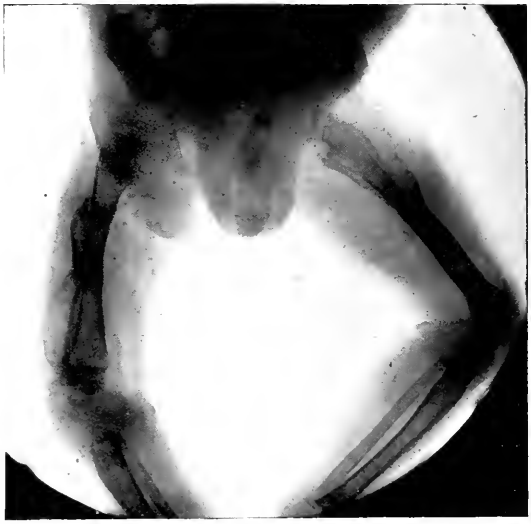


Fig. 5. Lower Extremities, Ninety-five Days After Admission, October 17, 1919. Calcification has progressed slightly. The line of increased density has disappeared from the right femur. The line of decreased density is better defined in the left and is very nicely demonstrated.

A third examination was made September 16, 1919, thirty-four days after the first and the beginning of treatment. At this time the hemorrhages appeared much denser, and this was regarded as evidence of calcification. Only a white line (on plate) was noted in the right femur and the line of absorption in the left was still marked, with increased density on each side. (Fig. 3.)

The fourth examination, made September

19, 1919, showed decided absorption at the upper portion of both subperiosteal hemorrhages and the lower part of the right. (Fig. 4.)

Another examination, made October 17, 1919, showed that calcification had progressed slightly. (Fig. 5.) At this time there was no evidence of rickets apparent around the knees although the child had had a "rachitic rosary."

In the meantime, during the interval between the fifth and last examination which was made March 20, 1920, the patient contracted diphtheria and was removed to the hospital for contagious diseases and not available for further examinations until that date.

An examination made March 20, 1920, showed the amount of calcification had decreased in both femurs. The cyst-like appearance noted at the lower end of the left femur, probably due to uncalcified hemorrhage, had disappeared. The dense line in the right femur at the lower end, seen distinctly in Fig. 3, had disappeared. The line of decreased density in the left femur had disappeared, but a dense line still persisted. There was now decided evidence of rickets in both ends of the bones at both knees. The femora had not grown any in length in the interval of twenty-two weeks between the last two examinations, as shown by actual measurement on the plates and by the position of the line of increased density in Fig. 6. It would seem as though scurvy did not interfere with epiphyseal growth, but that rickets did.

In this case the linear phenomena at the joints preceded the hemorrhages, but this is not always so. We have seen cases in which nothing but hemorrhage and subsequent calcification were ever observed throughout the course of the condition.

Fig. 6. Lower Extremities, Thirty-six Weeks After Admission, March 20, 1920. The areas of calcification are considerably less than the areas of hemorrhages as originally shown (Fig. 3). The cyst-like appearance in the lower end of the left femur has disappeared and only a faint line of increased density marks its location. There is now decided evidence of rickets at both knees.

THE COMBINATION OF ROENTGEN RAYS AND RADIUM IN UTERINE CARCINOMA*

By E. H. SKINNER, M.D.

KANSAS CITY, MO.

THE startling array of enthusiastic literature upon the successful use of radium in carcinoma of the cervix, uterus and appendages would seem to convince those entering this field of therapy that radium was the only radiant agent necessary. Possibly this may be true, and I may be guilty of urging unnecessary therapy when I insist that cross-fire roentgenotherapy in enormous doses through the abdomen and back should be used in conjunction with the application of radium to the actual site of the original growth.

But I am brought to this assertion (1) by personal experience, (2) by knowledge of the limits of tissue-activity of radium, and (3) the influence of *x*-rays upon the glandular tissue at distances greater than the accepted technique of radium permits, (4) by the reports of other radiotherapists in the literature, and (5) by the analogous reasoning of experimental *x*-ray and radium exposures.

Personal Experience: It has been my practice to accept no case for postoperative radiotherapy of a pelvic lesion unless deep *x*-ray intensive exposures through multiple portals of entry were used in an attempt to control the lymphatic metastasis at the same time that radium was applied to the cervix or intra-uterine.

It is believed that the results obtained by roentgen therapy alone, before radium came into our possession, warrant its continuation.

By observation, we have acquired a criterion of prognosis in these cases, which is that cases which exhibit an early tanning of the skin offer the best prognosis. It is realized that tanning is a matter of skin type to a certain extent, and that it could be a matter of dosage and filtration. But when a uniform technique is used daily, we constantly note that the cases which tan quickly are doing better than those which which do not tan. We are convinced that this is a worthy observation, as variations in technique did not produce tanning in the case that was losing the fight.

Limits of Tissue Activity: It is generally acknowledged by most authoritative investigation that the limits of radium activity producing reduction of cancer cells is 2 to 3 cm. We are all thoroughly familiar with the action of radium locally at the cervix and within the uterus, and the results continue to startle even those who see these results daily and in number. But the activity of radium to the pelvic lymphatics and along the channels of metastatic progress of the disease is not possible unless there is an open operation which permits the planting of radium directly to the suspicious tissues, or unless a large amount of radium is available to reproduce the effects of cross-fire roentgenization of these tissues. I venture to remark that there are probably not three places in America where such an amount of radium is available, and, on the contrary, it may be considered that there are 200 or more radium therapeutists who possess sufficient radium for its proper local application. To each of these many radium therapeutists there are certainly available ample facilities for cooperative roentgen therapy.

The limits of roentgen therapy are not measured by 2 or 3 cm., and the ability to cross-fire and thus accumulate *x*-ray tissue effects at any depth is simply a matter of careful and tedious technique. In estimating the amount of deep roentgen therapy, one only has to judge the distance of the tissue planes of metastatic interest and cross-fire as many areas as the distance demands. By

*Read at the Fifth Annual Meeting of THE AMERICAN RADIUM SOCIETY, New Orleans, La., April 26, 1920.

estimating x-ray dosage experimentally in masses of tissue, Cole, Pfahler, and Levin have shown that it requires six skin erythema doses to produce an erythema dose 4 cm. below the skin plane; at 3 cm. it requires 4 erythema doses. It should be realized that pressure upon the abdominal wall will decrease the necessity of more areas by decreasing the distance, and it has also been shown by Schwarz that skin made anemic by pressure will permit a larger erythema dose.

Reports of Radiotherapists in the Literature: Dr. von Seuffert, associated with Doëderlin, reported 152 cases of carcinoma of the uterus and cervix, all treated with radium, and one-third of them with radium combined with the x-ray. At the time of his report, several of the cases were still under treatment, but 31 had been discharged as successfully treated, and of these, 10 had been classed as inoperable upon admission. In none of them was there recurrence up to the time of his report. The Munich clinic went to the extreme view of treating even operable cases by radiations in preference to operation.

Hernaman-Johnson uses the x-ray for preoperative and postoperative treatment and also uses it in conjunction with radium for the inoperable cases, depending upon the x-ray for treatment of the area surrounding the growth or any part where metastasis seems probable.

The statistics given by Warnekros are of interest. They cover two periods, during the first of which no x-ray treatments were used, while during the latter, the cases were systematically rayed. In the period from 1911 to 1914, he reports 119 cases that were operated but not rayed and in which 66 died of recurrence. In the period from 1914 to 1916, he reports 55 cases that were operated and systematically rayed, of which only 11 died of recurrence; thus the percentage of recurrence in the first series was 55 per cent as against only 20 per cent in the rayed series.

Drs. Kroenig and Gauss of the Freiburg clinic, where the successful use of mesothorium treatment on cervical tumors caused wide-spread optimism, use the combination of x-ray and radium in a majority of their cases, considering this as a means of obtaining quicker results. The Freiburg clinic is fortunate in possessing a large amount of mesothorium, and Kroenig speaks of using this in a cross-fire method, similar to the cross-fire x-ray application. He explains his whole technique of radiant therapy as being worked out by following the analogous experiences in deep x-ray therapy.

Bumm and Voight have reported 13 cases of carcinoma of the cervix that were treated with deep roentgen therapy in combination with mesothorium. These were all inoperable cases and were influenced by the treatment to such an extent that they became operable with good results. The cases received large doses of the hard rays. Bumm has gone farthest in the use of giant doses of the hard rays, not hesitating to give 100 erythema doses.

Dr. Schmitz (Chicago) also advocates the use of combined x-ray and radium therapy for pelvic carcinoma. He uses the gamma rays and x-rays as a postoperative measure in every instance to attack any mestastases along the hypogastric or iliac vessels and any cancer remaining in the field of operation. In all cases, microscopic diagnosis was made of the tissues before and during the course of treatment to see whether any changes were brought about in the cancer, and it was invariably found that after from three to six weeks, cancer cells could no longer be demonstrated in the tissues.

Oudin and Zimmern speak of the value of a combination of x-ray and radium therapy for deep cancers, and of the many reported cures of uterine cancer, although adding that in cases which are clinically revealed only in an advanced state and where the organs are already deeply invaded, entire success cannot be expected. However, even in such cases, radiotherapy has been able to reduce the cancer to such an extent as to render it operable or to prolong life and ameliorate

conditions by the stopping of the foul discharge and the relief from pain. Oudin's conclusions from histological studies are that the x-rays have the power of destroying the pathological epithelial cell before affecting the normal epithelial cell at all, and states it as a fundamental law of the biologic effect of the x-ray, that the elements constituting all cancers manifest only a mediocre tendency to differentiation, and must offer a greater sensibility than the tissue of more elevated function of which they present the type.

This question of the vulnerability of neoplastic tissue has been followed up in clinical and physiological observation. The cells are destroyed more readily in their lower state of development than in their more adult state. The aim of postoperative radiations is not only to destroy any cells which may have been left, but to prevent in the earliest stages the development of recurrences, and with this idea in mind the irradiations, according to Oudin, should be continued for a length of time, at increasing intervals, sufficient to cover the ordinary period of probable recurrence.

The x-rays cannot be regarded as strictly selective in their effect upon tissue, but they are to the extent that there is a certain intensity at which they have the effect of destroying carcinomatous tissue while stimulating the growth of connective tissue around the carcinomatous mass. If the ray intensity is less than enough, the neoplastic tissue will not be destroyed, while if the ray intensity be too great healthy tissue may be injured. Filtration is employed to guard against the latter danger to some extent, and there is an increasing tendency among radiotherapists to apply massive doses rather than the smaller dose over a longer period, or with greater frequency. The results of experiments by Hill and others lead to the question whether the cancer cells do in time tend to establish an immunity to the rays. If this is so, it would explain the observations already made that clinical experience has proved the massive dose to be more advantageous than repeated doses, and also the fact that recurrences usually are less responsive to treatment with radiations.

The successful work of Bumm with his massive doses of hard rays demonstrates that the danger of overdosage is less to be feared than the reverse. Wertheim in commenting upon his report of 18 cases treated by radium and mesothorium in a period of two months, says his belief is that, although in 16 cases examination proved the retention of cancer rests, longer treatment would have removed these. In cases where the x-ray is employed, its function is to work from the outside of the growth, while the radium works from the center, and thus to shorten the length of the treatment as well as to afford additional security.

The effects obtained on cells by the gamma rays of radium and by the hard x-rays are the same according to Wickham, Pusey, and others, the chief difference being in the intensity and practicability of application.

Case calls attention to the fact that the highest gamma rays stand only a little higher in wave length than the hardest x-rays now available, and the hard x-rays now in daily use are reduced only 10 per cent by going through 12 or 13 centimeters of tissue. By experiment, he has established the fact that with 50 mg. of radium enveloped in a gold tube, such as is used for deepest therapy, twenty hours are necessary to accomplish what 50 milliamperes of current will do in 8 seconds when filtered through 2 mm. of brass, the distance from the plate being 15 inches in both instances. With the radium at 4 cm., the time needed to produce similar changes was longer than with the x-ray at several inches distance.

The question of the effect of the x-ray on the ovarian function causes some hesitation as to its use in the case of younger women. The effects of radium and of x-rays are similar in this respect; but the limited extent of the action of the gamma rays and the

manner of its application gives some opportunity to protect the ovaries from its rays. However, the advantages of the treatment and the possibility of the prevention of recurrence will, in most cases, appear to offset this risk. If it is possible by the combination of the two treatments to clear away the original carcinoma and to give the patient the greatest amount of security possible against future attacks, then all that is professionally possible has been done.

BIBLIOGRAPHY

1. Cole. *Surg., Gynec. & Obst.*, Oct. 1915, xxi, 522.
2. Pfahler, Am. J. Roentgenol., 1915, ii, 675.
3. Levin. *Surg., Gynec. & Obst.*, 1915, xxi, 374.
4. Von Seuffert. *Strahlentherapie*, 1913, ii, 714-732.
5. Warnekros. *Münch. med. Wchnschr.*, 1917, lxiv, 865-905.
6 Kroenig and Gauss. *Zentralbl. f. Gynäk.*, 1913, xxxvii, 153.
7. Schmitz. *Surg., Gynec. & Obst.*, 1916, xxiii, 191.
8. Oudin and Zimmern. Radiotherapie, 1913, Ballière, Paris.
9. Case. *Surg., Gynec. & Obst.*, xxiv, 580.

RADIUM TREATMENT IN 600 CASES OF MENORRHAGIA*

By LEDA J. STACY, M.D.
Section on Medicine, Mayo Clinic
ROCHESTER, MINN.

As the scope of treatment in any field of medicine increases, the results obtained in the individual case depend largely on the judgment used in selecting its form. Formerly surgery was the only effective treatment at our disposal in the management of menorrhagia and uterine myoma. We have now the roentgen rays and radium as definitely recognized therapeutic agents; and as our knowledge of the endocrine glands becomes more complete the internal secretions will be added to the therapeutic agencies which may be used in the treatment of menstrual disturbances.

Surgery is still the treatment of choice for young women who have definite fibroids causing menorrhagia, or for those who have a normal sized uterus but a history suggesting the presence of an intra-uterine polyp or small submucous fibroid, and for those with a history suspicious of malignancy of the fundus of the uterus. We believe that the large fibroids are best treated by hysterectomy as a certain means of quickly removing the tumor, without the possibility of degenerative changes occurring later. It has been our policy to limit the use of radium to fibroids the size of a three and one-half to four months' pregnancy, unless there is a definite contraindication to operation.

A hysterectomy should be advised in the cases in which there is a history suggestive of malignancy, for a negative diagnostic curettement is not to be relied on in the definitely suspicious case, as the curette may miss the involved area.

In the young woman who has a definite fibroid causing menorrhagia an abdominal myomectomy is the preferable treatment. By this method the tumor is removed, the menorrhagia controlled, and a uterus is preserved which is capable of carrying on the functions of menstruation and child-bearing.

If a young woman has menorrhagia without a demonstrable tumor which cannot be controlled by medical treatment or by curettement, an abdominal hysterotomy may disclose a small submucous fibroid or polyp so situated that it could not be reached by the curette. Hysterotomy has been done in twenty-five cases at the Mayo Clinic; in seventeen in connection with a myomectomy, and in eight primarily as an exploration of the uterine cavity.

*Read at the Fifth Annual Meeting of The American Radium Society, New Orleans, La., April 26, 1920.

It has been stated that the mortality is higher in myomectomy than in hysterectomy and that a later operation is often necessary; but in a series of 615 abdominal myomectomies performed at the Mayo Clinic from January, 1891, to January, 1920, the mortality was 0.5 per cent. Reports received from 373 patients show that twenty-one had a subsequent hysterectomy; two of these were performed immediately after the myomectomy because malignancy was found on microscopic examination. In eleven cases the operation was done five or more years after the myomectomy. A curettement was done eight years after myomectomy in one case, and a tumor was removed from the uterus in another thirteen years after the first operation. One patient had a child one year after myomectomy and a hysterectomy one and one-half years after the birth of the child. A second operation was necessary therefore in only 3.3 per cent of the series of 619 myomectomies.

The incidence of pregnancy occurring after myomectomy was most satisfactory. Reports have been received from 373 patients in answer to questionnaires. Two hundred ninety-six of these were married women. Forty-four have been pregnant since operation; eleven have had more than one child, and fifteen were definitely and two questionably pregnant when they reported. Six have had miscarriages. Two patients have been married since the operation; one has two children and one has one child. Twenty-three of the forty-four women who became pregnant after the myomectomy had not been pregnant before operation. At the time of operation nineteen patients were pregnant; in five the pregnancies were extra-uterine and in one case the fetus was dead. Pregnancy terminated in two of these cases in two or three days after operation. Six patients have been heard from who went to full term. One had a vaginal cesarean section six months after myomectomy; one had an abdominal cesarean section two years after operation. In both cases the child was living and the mother made a normal recovery.

Although the length of time which has elapsed since the use of radium is too short to allow a comparison of the results of the radium treatment and myomectomy as to the incidence of subsequent pregnancy it is doubtful whether pregnancy will occur in so large a percentage of cases after the application of radium as after an abdominal myomectomy.

Of the series of 600 patients with menorrhagia with or without uterine myomas treated with radium at the Clinic from July, 1915, to January, 1920, 438 have been heard from. Sixty-nine of these were married women under thirty-five. Normal full-term pregnancies occurred in three patients; two were women of twenty-two who had been given two tubes of 25 mg. radium for four hours each; the other, aged twenty-six, had been given 25 mg. for nine hours. One patient aged thirty-one with small multiple fibroids was given two 25 mg. tubes for six hours and the periods became regular and normal; three years later she gave birth to a normally developed full-term dead child. Menstruation again became profuse two months after confinement and four months later 350 mg. hours were given. Two days after the treatment the patient developed a rapid pulse and evidence of shock, without rise in temperature or evidence of peritonitis, and died twelve days later. This is the only death in our series and has not been satisfactorily explained. One woman gave birth to a premature dead fetus after receiving 23 mg. radium for ten hours, and another gave birth to a premature deformed fetus, after receiving 50 mg. for six hours. One woman of thirty-seven who had 250 mg. hours had two miscarriages at three and six months. One woman of twenty-five, after 25 mg. for ten hours, is now six months pregnant. One woman aged thirty who had had 25 mg. radium for ten hours was questionably pregnant at the time she reported.

In the treatment of menorrhagia in patients more than thirty-five who have a fibrous uterus or a small myoma, and in younger patients in whom myomectomy or

hysterotomy is not indicated or in whom currettement has not controlled the menorrhagia, radium is a very satisfactory therapeutic agent. Radium should not be used, however, for patients who give a clinical history or present physical signs of pelvic infection or of pyometritis, nor for those who complain of chronic pelvic pain, since the application of radium may light up a quiescent infection. We have had three cases in which operation was done because of the infection after the application of radium, in one in five weeks, in one in six weeks, and in one in three months.

In our series of 600 cases were 122 women under thirty-five; nineteen were twenty-five or under. Eighty-nine were heard from. The average dose of radium given to these patients was 293 mg. hours. Menorrhagia was controlled by one treatment in 55.6 per cent; a second treatment was necessary to control the menstruation in seventeen cases. In twenty-five the periods were reported normal in amount, in eleven irregular and scant, and in six menstruation ceased; three of these patients, aged twenty-eight, thirty and thirty-four, respectively, had 300 mg. hours. Hysterectomy was performed later in six patients; one patient aged thirty-two was operated on eight months after receiving 400 mg. radium hours without improvement; one aged thirty was operated on one year after receiving 375 mg. hours treatment without improvement; one aged twenty-eight was operated on after one year because of pelvic pain, although the profuse flow had not returned; one aged thirty-one was operated on after receiving 200 mg. hours treatment without relief; and one aged twenty-seven (a case of hemophilia and myoma) was given 300 mg. hours treatment, then transfused and given 400 mg. hours. Menstrual periods were regular for eight months, followed by continuous flowing for five weeks, when the hysterectomy was performed. One girl of sixteen was given 100 mg. hours one year after a currettement with only temporary improvement; the flowing was more or less continuous, and two years and nine months after the radium treatment a hysterectomy was performed; adenocarcinoma of the fundus was found. Abdominal myomectomy was performed in seven patients who received only temporary benefit following the radium treatment; two of these had had radium treatment a second time. We attempt to give the women under thirty-five enough radium to control the symptoms, but not enough to stop menstruation, and it is difficult to judge the amount necessary in each case. It is better to give a small dose, however, and if there is a recurrence of the profuse flow, repeat the dose in three, four or six months, than to give enough at the first treatment to stop menstruation.

Patients more than thirty-five are given larger initial doses, as it is not so important that menstruation shall continue. We have tried, however, to give a dose to all patients under forty which will control rather than stop menstruation. We have seldom given more than 50 mg. for fourteen hours at one treatment, since we believe that it is better to repeat the treatment if necessary, as it is sometimes in cases of a fairly large tumor. There were 478 patients more than thirty-five, and of this number 349 have been heard from. In eighty-one (23.2 per cent) of these the examination showed the uterus to be "fibrous" or not "large." In 220 cases the uterus was graded 3 on a scale of 1, 2, 3, 4 or the fibroids graded 1, and in twenty-nine the fibroids were graded 2 or 3. Thus in the large percentage of cases the treatment was confined to the smaller tumors and the large doses given by many physicians were not used.

In the series of 349 patients it was necessary to repeat the treatment in sixty-four, and an operation was done later in twenty. Only four of the twenty were given a second radium treatment, and two had operations elsewhere too soon after treatment to obtain the effect of the radium. Menstruation became regular and normal in thirty-nine (11.17 per cent).

Of the patients more than forty, 263

were heard from; in 185 (70.35 per cent) of these menstruation had ceased. Only fourteen of this group were given two treatments; four were given the two treatments close together; the other ten received the second treatment after from one month to one year. In the larger percentage of those cases in which menstruation ceased there were two periods following the treatment before the cessation. Improvement in general health was reported in 231 cases, and gain in weight in 157 cases. No improvement was reported in sixty-eight.

Letters were not sent to patients treated within the last three months, because enough time has not elapsed to show what the ultimate results will be.

Our technic has not varied materially from that which I described in a paper published in 1918, except that we now use either the emanation or the radium element, and are using slightly larger doses for older persons, but usually not more than 700 mg. hours. If this is not sufficient we prefer to repeat the treatment in a few weeks or months.

CONCLUSIONS

1. In young women with fibroids causing menorrhagia radium should be used only in carefully selected cases, and in small amounts in the initial treatment.

2. Pregnancy may occur after the application of radium, but in a small percentage of cases only.

3. Abdominal myomectomy is preferable to radium in the treatment of women under thirty-five who have definite fibroids causing menorrhagia.

4. Radium is the ideal treatment for menorrhagia in patients more than thirty-five who have a fibrous type of uterus, and for patients who have small fibroids and menorrhagia.

5. In cases in which the history is suggestive of carcinoma of the fundus an abdominal hysterectomy is the safer procedure, and should be advised even if the diagnostic curettement is negative for malignancy.

6. Unless there is a definite contraindication we believe that large fibroids should be treated surgically because of the possibility that degenerative changes may occur in a tumor in which the blood supply has been interfered with, and because of the possibility of a mistaken diagnosis.

BIBLIOGRAPHY

1. Clark, J. G. The treatment of myoma uteri with radium. *J. Am. M. Assn.*, 1919, lxxiii, 957-959.
2. Stacy, Leda J. The treatment of menorrhagia with radium. *Minn. Med.*, 1919, ii, 88-92.

THE CLASSIFICATION OF UTERINE CARCINOMA FOR THE STUDY OF THE EFFICACY OF RADIUM THERAPY

By HENRY SCHMITZ, A.M., M.D., F.A.C.S.

CHICAGO, ILL.

At the fourth annual meeting of the American Radium Society held at Atlantic City, June 5, 1919, John G. Clark of Philadelphia stated: "The question of technique of application (of radium) should be referred to the Research Committee of this society for standardization. As soon as possible we should lay down definite rules for dosage, repetition of treatments, care of the patient, follow-up systems, etc. Only by such standardization may we reach a common ground for discussion and observation. We have two schools of radium therapy—one having unlimited amounts of radium, the other in comparison infinitesimal amounts. In considering results, therefore, they should be comparative between those who have maximum and those who have minimum amounts of radium." Reviewing the very voluminous literature on the treatment of uterine carcinomata with radium we are at once confronted with the fact that a uniform or standardized method of the application of the rays does not exist. The necessity for a full discussion of the subject is obvious and explains the motif of this paper.

Radium therapy may well be considered under three headings: (1) The indications for the treatment, (2) the technique and the clinical manifestations and results observed during and after the treatment, and (3) the evidences of postmortem examination.

We commonly classify cancer cases for purposes of treatment into several groups: operable, borderline, inoperable, terminal or hopeless, and recurrent cases. We thereby indicate at once the method of treatment to be applied in the first group.

An operable carcinoma is one in which the primary growth is clearly confined within the boundaries of the uterus. A surgical removal of the generative organs will effectually eradicate all carcinoma cells from the body of the bearer. A permanent cure is the rule.

A borderline case is one in which the primary growth is advancing into one of the contiguous organs or tissues. An extended radical abdominal panhysterectomy will not always result in a complete removal of all cancer elements. A recurrence is probable. A permanent cure is impossible in the greater percentages of these cases.

Clearly inoperable cases may be divided into two groups: The one shows invasion of the bladder, rectum, parametria or regional lymphnodes—of either one, several or all of these structures; yet the uterus and adnexa are not fixed to the bony pelvis. The other is characterized by an invasion of all of the pelvic structures which are firmly fixed to the bony girdle. The iliac and lumbar lymphnodes are mostly already involved and metastases have probably formed in distant organs. They are absolutely hopeless from the standpoint of treatment.

The recurrent cases are those in which the cancer recurred after a surgical incision. Should the recurrence be located in the vaginal fornix they yield readily to treatment. Should the growth recur in the regional lymph glands or the distant portions of the parametrii, they are hopeless.

Accordingly the grouping is as follows:

1. Cases clearly operable after a physical examination.

2. Cases doubtfully operable—"Borderline cases."

3. Cases in which a radical operation is absolutely impossible.

4. Cases so far advanced that all treatment is hopeless and that are subjected to it for purposes of palliation.

5. Cases that recur after an abdominal panhysterectomy.

It is obvious that we must adhere to a classification as given to determine fixed rules for a proper mode of treatment, to enable us to arrive at a proper determination of the efficacy of any therapeutic measure, and to compare the value of ray therapy with other treatments advocated.

Clearly operable cases indicate a radical, extended abdominal panhysterectomy. Should contraindications exist, then they are subjected to radium treatment. As soon as the members of this society have collected a sufficiently large number of clearly localized carcinomata of the uterus treated exclusively with radium and which have remained well and free of any recurrence for five years or more, we may then decide which mode of treatment gives the best total curative results.

Many therapeutists have proposed a prophylactic raying following operations to prevent recurrences; others recommend preoperative raying to cause a degeneration and death of the tumor elements first, thus to prevent accidental dissemination of viable carcinoma cells during the progress of the operation. It is claimed that by either method the efficacy of surgical procedures would be improved. The value of such combined treatment can be determined only by a proper subgrouping and a careful collection of these cases. The advantages of such procedures would soon be established beyond any doubt.

The results of surgical treatment of borderline cases have been so disastrous that most surgeons refuse to treat them. This class of patients, however, forms the most ideal group for radium therapy. When we began the investigation of the value of radium therapy we were quite undecided whether a patient should or should not be subjected to a radical excision of the pelvic organs after a complete local regression of the tumor was obtained by ray therapy. Also we did not know whether an excochleation and cauterization of the tumor mass preceding the course of radium treatment would or would not improve the prognosis. Therefore we had to subgroup these cases, stating (a) whether they were treated with radium only; (b) whether a local healing was obtained with radium and an excision followed, and (c) whether an excochleation and cauterization preceded the radium treatment.

The clearly inoperable cases of Group 3 form the largest number of cases. Here also the same conditions prevail as in cases of Group 2. Therefore a similar subgrouping was adopted: cases treated with (a) radiation and panhysterectomy, (b) extensive cauterization and panhysterectomy, and (c) radiation only.

The hopeless and recurrent cases require an entirely different form of treatment, as will be stated later. Tables I to V show at a glance the grouping of the cases that were treated in our clinic from April 1, 1914, to April 1, 1920. They also give information about the time elapsed since treatment in those patients that have survived so far, and the time elapsed between treatment and subsequent death.

In grouping the cases and stating results we have not made any effort to classify them according to the technique employed. The latter has been changed from time to time. At first we used 50 milligrams of radium element, filtered with 2 mm. of lead or 1.2 mm. of brass, arresting the Sagnac rays by a pure para-rubber filter of 3 mm. thickness. The 25 milligram tubes were arranged either parallel and placed against the cervix, or in tandem and inserted into the crater. The applications lasted 20 to 24 hours, and were repeated every second or third day until 6,000 to 14,000 milligram element hours were obtained. We soon observed that 4,000 to 6,000 milligram element hours' applications usually caused a marked restitution of the diseased area to nearly normal, and decided to apply the dosage in one sitting, allowing the 50 milligrams to remain *in situ* for three to five days. Finally we shortened the duration of the application by using from 100 to 200 mg. of element. If a decided change for the better did not occur in

the local condition within three to six weeks another course of treatment as intensive as the first one would again be applied.

Whatever method we used, none seemed to give as satisfactory results as the twenty-four hour interval application of 50 milligrams of radium element. The patients objected less, had fewer systemic reactions, rarely an infection and never an excitus directly attributable to the treatment. The following study and investigations enabled us to formulate a mode of treatment that we consider ideal, safe and successful.

The technique of radium therapy must be based on the diseased conditions found in the pelvis in uterine carcinoma. The purpose of the treatment is to destroy the cancer completely without producing serious injury to the surrounding healthy tissues and organs which would render illusory the first object.

The vaginal portion of the cervix lies in the interspinal line; the cervix, lower part of the uterus and parametria lie somewhat higher. A plane through the antero-posterior diameter of the midpelvis well defines the limit of the disease upward. Cervical carcinoma spreads by invasion of the vaginal vault, by infiltration of the lymph vessels of the parametria, by extension into the paravaginal tissues and along the sacro-uterine ligaments to the pararectal tissues and rectum, and through the vesico-vaginal septum to the bladder. The part of the pelvis between the pelvic outlet and the midpelvic plane contains all these structures and is the space which must be rayed. The transverse and antero-posterior diameters of the midpelvic plane are 12 cm. long, the transverse diameter of the pelvic outlet is 11½ cm. long, while the antero-posterior diameter is 12 cm. The cervical canal lies in the pelvic axis. Hence *a radium capsule placed within the cervical canal will disperse the rays evenly through the pelvic cavity. The rays must penetrate 6 centimeters of tissue all around with such an intensity at the periphery that carcinoma cells at this distance become destroyed.*

We must also endeavor not to injure permanently the vital organs and structures located in this area, namely, the rectum, the bladder and the ureters. The posterior wall of the bladder, the anterior wall of the rectum and the ureters are 1½ centimeters distant from the cervical canal if the organs are empty. Should the bladder and the rectum be filled they are forced closer to the cervix and the distance is reduced to about one-half. Therefore it is necessary that the bladder and the rectum be empty and left empty during the treatment. This will be understood when discussing dosage. *We insist on the insertion of a retention catheter in the bladder and the flushing of the bowels immediately before beginning the treatment.*

The amount of radium to be used depends on the extent of the radioactivity of the preparation of radium and the extent of the area to be rayed. We must use the smallest amount permissable. Overdosing leads to dangerous complications, as extensive necrosis and destruction, infection, painful cicatrical tissue formation causing stricture of the rectum, vagina, ureters, and so forth. The systemic reaction, also, places a limit on the amount of radium it is advisable to use, as rapid disintegration of diseased and normal cells leads to severe absorption and sometimes pronounced toxemia that might prove fatal.

The object of the application of radium is to apply a given amount for a sufficiently long time to destroy the deeply located pathologic processes within the pelvis without permanent injury to the healthy tissues and organs. This dosage can be determined only by the biologic measurements of each radium preparation. Dosage is a complex quantity and comprises the quantity of radium in milligrams of element, the length, width and depth of the container, the purity of the salt, the filtration, such as rubber and metal filters, the distance of the radium from the area treated, the time duration of the exposure, and the time intervals between exposures. The tubes used in our clinic contain each 25 milligrams of the element in

the form of the insoluble sulphate of a chemical purity better than 94 per cent. The salt is packed in a glass cylinder of an outer diameter of 2 mm. and a length of 6 mm. The glass cylinder is inserted in a silver capsule of a wall thickness of 0.5 mm. and a length of 1.75 cm. We place two such capsules in a brass filter of a wall thickness of 0.7 mm. The metal filter therefore is 1.2 mm. and effectually absorbs the beta radiation. The Sagnac rays formed in the metal filter are absorbed by a rubber tubing of a wall thickness of 3 mm. in which the radium carrier is inserted. If such a container is placed over healthy skin at a distance of 1 centimeter between the axis of the radium capsule and the skin surface, then a reddening of the skin is observed within ten to fourteen days after an exposure of somewhat less than two hours. This dosage is termed an erythema skin dose and amounts to about two times 50 milligrams, i.e., 100 milligram element hours (mgehrs.). If the exposure is increased to two and one-half to three hours a blistering appears after ten to fourteen days. A burn of the second degree has been caused. Should the exposure be extended to twenty hours a burn of the third degree results—the epithelium has been totally destroyed. The erythema and the second degree burn heal very rapidly without leaving a permanent defect behind. Should the radium carrier be applied at a distance of two centimeters then an erythema dose is obtained within eight hours, and a blister dose within twelve hours, because the intensity of the rays decreases inversely with the distance.

The sensibility of carcinoma tissue to rays is held to be about one-half greater than that of normal tissue. This does not agree with the findings of Kroenig and Friedrich. They found that an erythema skin dose is obtained by an application of rays measuring 170 electrostatic units determined with a Wolf electrometer. They consider this the lethal skin dose. The dose that causes after a certain time interval, usually fourteen to twenty days, a visible and palpable decrease of the carcinoma growth is termed a carcinoma dose and is 150 e. The cancer sensibility quotient is obtained by dividing the skin dose by the cancer dose, i.e., $170 \div 150 = 1.15$. By biological tests we found that the erythema skin dose is about 100 mgehrs. Hence the cancer dose must be $170 : 150 = 100 : X$ and $X = \frac{150 \times 100}{170} = 88\ 4/17$ mgehrs., or in round numbers 90. It has been impossible to install an electrometer to verify the measurements of Kroenig and Friedrich. I do not see any objections to them as the experiments have been very scientific, thorough and accurate. Applying the law of the inverse ratio to these results we find that the lethal erythema skin doses are 100, 400, 900, 1600, 2500 and 3600 mgehrs. for distances of 1, 2, 3, 4, 5 and 6 cm. respectively; while the corresponding cancer doses are 90, 360, 810, 1440, 2250 and 3240 mgehrs.

If the radium carrier is placed in the cervical canal after a proper dilatation, then the posterior wall of the bladder and the anterior wall of the rectum are forced two centimeters distant from the radium source. A ten hour application, or 500 mgehrs., would not injure the bladder or the rectal walls to the extent of a second degree burn, as it takes four times 150 or 600 mgehrs. to do so. However it would visibly and palpably damage the cancer tissue within a radius of two centimeters, as the cancer dose would be four times 90 or about 360 mgehrs. We may assume that the healthy cells of the bladder and the rectum will rapidly recover so they will bear another application without permanent harm after an interval of twelve to fourteen hours, and so on until seven treatments of 500 mgehrs. each have been applied on seven consecutive days, i.e., a total amount of 3500 mgehrs., the amount necessary to degenerate all carcinoma cells as far as the bony pelvic wall. As a matter of fact cystoscopic examinations made at ten day intervals and extended over a period of six weeks have verified the correctness of the assumption. We have

never observed a marked change in the bladder mucosa except an intense reddening.

The patient is subjected to careful re-examinations ten days, thirty days and then every forty-five days for two years and every three months for an additional three years. Exact records are made each time. They note the visible findings of cervix, vagina, bladder and rectum and the palpable conditions of the uterus, parametria and regional lymph glands obtained by vaginal and rectal palpation. The radium treatment is not repeated unless a recurrence is surmised.

The after-treatment must also comprise adequate drainage of the uterine cavity. Pyometra has been frequently observed. In such cases a soft rubber T drain is inserted into the uterine cavity after each removal of the radium carrier and continued for several weeks after termination of the treatment until the secretion is reduced to a clear and negligible amount.

Three to four weeks after treatment a careful examination reveals a visible and palpable decrease of the cancer area. The cervix shows local healing. The uterus is palpable and movable, the parametria are softer in consistency, reduced in size and again movable and very often rendered free of any induration.

Such favorable results can be obtained only by a careful selection of cases. The technique described is indicated and can be successfully applied only in cases of Groups 1, 2 and 3. It is absolutely useless in cases of Group 4, the terminal cases. It is impossible of execution in cases of Group 5 on account of the absence of the uterus. Cases in Group 1, of course, are subjected to abdominal panhysterectomies after a preliminary radiation.

Properly selected cases reveal a visible and palpable subsidence of the cancer growth after a correctly applied radium course. A panhysterectomy could be easily performed. The operation would not present unsurpassable technical difficulties. Could the dangers of an added operation hold out to the patient a more favorable prognosis? Out of a total of 208 uterine cancers treated from April 1, 1914, to April 1, 1920, with radium, 22 cases were assigned to Group 2 and 82 cases to Group 3. Of Group 2, 13 were subjected to an abdominal panhysterectomy after a recession of the diseased tissues to an apparently normal state after radium treatment. Of these 5 are living and 5 have succumbed either to the operation or to a recurrence, and 3 did not report. Of Group 2, 9 were treated with rays only—7 are alive and well, and 2 have died. Sixteen cases of Group 3 were subjected to panhysterectomies after an apparently local healing. Two of these are living, while fourteen have succumbed or did not report. Twenty-five cases were subjected to an excochleation, cauterization and radium treatment. Four cases are living, 18 died and 11 did not report. Forty-one cases were treated with radium only. Eighteen of these are well and free of recurrence, while 11 died and 12 did not report. (See Tables I, II, III, IV and V. The latter also state the time elapsed since treatment of those living and known dead.) Patients of Groups 2 and 3 treated with radium only and not subjected to panhysterectomy, excochleation or cauterization have a better chance all around. If local healing is obtained we should not subject the patient to an unnecessary operation. Preliminary excochleation and cauterization also do not offer the patient any additional benefits. They render her chance less favorable in spite of the added physical and material sacrifices.

Recurrences after a local healing of the carcinoma with radium appear within six to nine months, rarely later, following the termination of the treatment. It is a noteworthy fact that such recurrences are very refractory to radiations, probably due to the heavy connective tissue reparative process. Exceptionally, an arrest and recession of the recurrence may take place following another course of radiation. If the growth does not react to the treatment and if the recurrence is confined to the uterus we then advise surgical eradication. Should the recurrence ap-

pear in the regional lymph nodes we have subjected the patients to laparotomy, buried canals into the tumor masses, in which we placed rubber tubing. The tubes are secured with silk stitches to the parietal peritoneum of the posterior abdominal wall and also to stab incisions in the anterior abdominal wall. The length of the tubes must be carefully determined. The radium applicators are secured to a heavy silver wire which easily adapts itself to the course of the tubing. Two to four applications of 50 milligrams radium element of ten hours each and intervals of twelve to thirty-six hours between applications are given.

We have subjected five patients to the procedure without any apparent benefits. Two patients succumbed to peritonitis. Three had a tedious convalescence. Of the latter one succumbed six weeks later. She had a large metastasis in the liver. Another expired six months later from a carcinomatosis. The third one reported not to be relieved and has not been heard from since. In spite of these discouraging results we shall continue the treatment in specially selected cases of such recurrences.

Cases of Group 4 have been benefited only exceptionally by the above outlined treatment. The fact that the dangers from toxemia due to the absorption of split products and infection are very great, has induced us to desist from the plan. We usually apply 50 milligrams element for twenty hours placed against the crater. This will cause an arrest of hemorrhage and a subsidence of the putrid discharge. As soon as the symptoms of absorption or infection or both subside, i.e., in about ten days, we make a second application of 50 milligrams element for twenty hours within the cervical canal. Should reaction or infection not appear within three days, and if the examination of the blood does not reveal a leukopenia, then a full course as outlined for cases in Groups 1, 2 and 3 is resorted to.

We must also consider the clinical limitations or contraindications for radium applications. They are given by the systemic reaction of the organism and the possibility of infection.

Mild subjective disturbances, as nausea, or vesical and rectal tenesmi, do not necessitate an interruption of the treatment. Serious disturbances due to the absorption of cell constituents liberated by the degenerative and destructive action of the radium rays are intense weakness, apathy, anorexia, absolute refusal for intake of all food, serious changes in the blood elements, especially leukopenia, and finally radium cachexia. They compel an interruption of the treatment.

Infections result from the bacteria ever present in cancer tissues. The bacteria enter the pelvic organs and tissues through the injured mucosa of the vagina, uterus, rectum or bladder. The injuries result from necrosis or destruction by the action of the rays. Toxic substances accumulating in the bowel tract, the result of the toxemia, are also readily absorbed through an injured rectal mucosa. Bacterial invasion causes inflammatory changes in the paracervical, paravaginal and pararectal connective tissue, the uterine adnexa, the pelvic peritoneum terminating in diffuse septic peritonitis or sepsis.

The dangers can be avoided only by a correct dosage that gradually degenerates the tissues and avoids necrosis of the surface epithelium, especially of the rectum. A most careful asepsis observed in the application of the rays, insuring free drainage from the uterine cavity, and careful dilatation of the cervical canal to avoid all unnecessary trauma, must be insisted on.

The possibilities and limitations of radium therapy must be proven by microscopic examinations of all the pelvic organs and structures removed postmortem in patients who have succumbed following a course of radium treatment. By such careful and minutest microscopic examinations we can demonstrate the actual penetrability and curative efficacy of the rays in the tissues adjacent to the bony pelvis. The absence or absolute degeneration of all carcinoma cells in all the pelvic tissues, and the presence of a

connective tissue regeneration or cicatricial formation or necrotic areas are the criterions for the interpretation of a successful and efficient radium treatment. The presence of viable carcinoma cells, especially evidences of mitotic activity, undoubtedly would mean either that the treatment was deficient, or if correct, that radium cannot be considered a curative agent.

The reaction of carcinoma cells to radium rays varies depending on the histological structure of the neoplasm. The squamous cell carcinoma of the cervix, characterized by hornification or epithelial perl formation usually evidences a papillary arrangement of cells, i.e., cone formation with epithelial perls, edematous loose connective tissue and round cell infiltration consisting of plasma cells, eosinophiles, mast-cells, leucocytes and lymphocytes. This epitheliod carcinoma or acanthoma is usually found in the cauliflower like tumor, which is an everting, rapidly proliferating cancer without simultaneous extension into the tissues.

The changes caused by radium in the cells of the hornifying epithelioma are cytolysis and karyorrhexis, as vacuolation and granulation of protoplasm, destruction of the cell wall, destruction of the nucleus into amorphous débris and so forth, round cell infiltration and later on fibroblastic formation. The round cell infiltration is especially rich in eosinophiles, while connective tissue formation is really of secondary importance, the tumor disappearing by the action of phagocytes and necrophytes.

The basal celled epithelioma of the cervix is mostly found in the infiltrating variety of cervical carcinoma. The rays cause a necrosis in the central portion of the cones or alveoli characterized by the formation of amorphous masses and cell detritus, while the peripheral cells remain unchanged for a long time. As the treatment is continued all the cells become finally similarly destroyed and removed by phagocytes. The vacancies in the tissues are rapidly filled by fibroblasts. Necrosis and connective tissue formation are the characteristic reparation processes in this variety of carcinoma. The adeno-carcinoma shows a tendency to further growth when exposed to rays. However it soon succumbs if treatment is correctly carried on. Rapid degeneration of carcinoma cells with a rapid and profuse formation of fibroblasts are the regenerative processes characteristic for this cell growth.

These cell studies prove the possibilities of the therapeutic action of irradiation. However they do not prove the possibilities of unlimited penetration. To do this we must have recourse to postmortem findings. For this purpose we succeeded in obtaining the pelvic organs *in toto* of two women who died from intercurrent diseases subsequent to the administration of radium for carcinoma of the cervix. A short abstract of the histories and the microscopical tissue findings are herewith given.

Mrs. C. L., age fifty-five, married, nullipara, Augustana hospital number 42536, was admitted March 9, 1915, with a history of having a little blood coming from the vagina for the last three months, pain in the back and for the last four days also in the hips, and a sticky mucous discharge from the vagina at intervals of a day or two.

The uterus was anteverted, not freely movable, enlarged to about a diameter of 9 cm., and of soft consistency. A small hard mass of 3 cm. diameter was felt in the anterior uterine wall near the fundus. The parametria appeared thickened, the adnexa negative. Diagnosis, myoma uteri.

March 10, 1915: A supravaginal abdominal corpus amputation was performed. The uterine cavity was distended with a thick, yellow pus. The endometrium was necrotic throughout. A soft oblong myoma 3 by 2 cm. in extent was seen in the myometrium of the anterior uterine wall near the fundus. The ulceration and necrosis involved the mucosa of the cervical canal. Microscopic examination of frozen sections of the region of the internal os showed an adeno-carcinoma of a mildly malignant type with a marked leucocytic infiltration. The broad ligaments were hard and infiltrated.

The precarious condition of the patient forbade a radical extended panhysterectomy. The bleeding points were ligated, a drain inserted, the abdominal wall incision closed. The patient was placed in Group 2 for observation under radium therapy.

March 12, 1915: 50 mg. Ra. El. in 1.5 mm. lead filter and 3 mm. para rubber filter were inserted into the cervical canal for twenty-four hours, i.e., 1200 mgehrs. March 17, for twenty-three hours, i.e., 1150 mgehrs., and March 21, for twenty-three hours, i.e., 1150 mgehrs., total 3500 mgehrs. The patient had an uneventful recovery and left the hospital April 7, 1915. She accepted a position as a saleslady in a large department store and did not present herself for re-examination on account of lack of time until Dec. 12, 1916. At this time she complained of a gradully increasing pain in the left lower abdominal quadrant and an ever increasing difficulty to evacuate the bowels. The state of her general health was excellent. She was well nourished, had a clear skin, and was able to perform the arduous duties of her position without any difficulties. Rectal palpation revealed a band of firm tissue across the pelvis compressing the rectum. The diagnosis was obstruction of rectum due to recurrent carcinoma. Symptomatic treatment was instituted.

Soon after the patient entered the hospital an invalid. A marked distension of the left half of the abdomen was now present. She succumbed March 10, 1917.

The postmortem examination revealed complete obstruction of rectum due to a firm mass in the pelvis compressing the bowel, hydro-ureter and hydronephrosis on the left side due to compression of the ureter by the same mass. The pelvic organs were removed in one mass. This was cut in blocks, hardened and subjected to microscopic examination. It is evident whatever carcinoma cells are seen they are in a stage of pronounced degeneration; they are isolated, nowhere appearing in nests or solid masses. There is marked connective tissue formation throughout and the granulation tissue formation is very evident in the parametrium.

The absence of viable carcinoma cells and the penetrability of the rays with a sufficient intensity to cause degeneration of carcinoma cells in the glands adjacent to the bony pelvis is proven. The granulation process is evidently the cause for the progressive cicatricial contraction that led to an obstruction of bowel and uterus and ultimately to death.

Mrs. A. R., Augustana hospital number 44801, age fifty, married, nulli-para, was admitted October 26, 1915 stating to have had dysuria and frequent micturition for the last three months. She never had had vaginal discharges or hemorrhages, but was very constipated of late and complained of a feeling of heat along the small of the back.

Physical examination revealed a proliferating ulceration involving almost all of the vaginal mucosa including the cervical portion. The uterus and parametria were somewhat rigid, the recto-vaginal septum thickened, the rectal mucosa not involved. Cystoscopic examination of the bladder elicited an intense congestion of the mucosa with bulbous edema and trabeculation of the posterior bladder wall. Diagnosis: Carcinoma of cervix, Group 3. Microscopic diagnosis: Medullary epitheloid carcinoma.

October 27, 1915: 50 mg. Ra. El. were inserted into the lumen of the vagina for twenty-four hours, i.e., 1200 mgehrs. Dec. 6, 1915, the vagina was free of evidences of ulceration and 25 mg. Ra. El. were inserted into the cervical canal for twenty-four hours, i.e., 600 mgehrs., Dec. 26, 50 mg. Ra. El. intracervical for twenty hours, i.e., 1000 mgehrs., Dec. 28, 25 mg. Ra. El. intracervical for twenty-four hours, i.e., 600 mgehrs., and Dec. 29, 35 mg. Ra. El. intracervical for ten hours, i.e., 400 mgehrs. Total amount 3800 mgehrs. The patient died suddenly Jan. 21, 1916, while walking on the street.

The pelvic organs were removed *in toto* the same day and examined in the same manner as in the former case.

Viable cancer masses are evident in places, though degeneration is seen everywhere. It

is evident that we did not succeed in killing off the tumor. The amount of radiation is larger than in the previous case. However six weeks elapsed between the first and subsequent applications of radium. The effects of the first application could not be added to that of the subsequent course. Hence under dosation is responsible for the negative results.

We feel, indeed, sorry that we could not collect more postmortem examinations. We hope to be able to add quite a number of

TABLE I. CLASSIFICATION OF UTERINE CARCINOMATA.

GROUP 1. Carcinomata which were clearly operable after a physical examination.
- *Subgroup A:* Cases treated with preoperative Radiation and Panhysterectomy.
- *Subgroup B:* Cases treated with Panhysterectomy and Postoperative Radiation.
- *Subgroup C:* Cases treated only with Radiation.

GROUP 2. Carcinomata which were doubtfully operable: "Borderline Cases."
- *Subgroup A:* Cases subjected to Panhysterectomy and Postoperatice Radiation.
- *Subgroup B:* Cases treated only with Radiation.

GROUP 3. Carcinamata in which operation was absolutely impossible.
- *Subgroup A:* Cases treated with Radiation and subsequent Panhysterectomy.
- *Subgroup B:* Cases treated with an extensive Cauterization and Radiation.
- *Subgroup C:* Cases treated only with Radiation.

GROUP 4. Carcinomata so far advanced that all treatment was hopeless. They were subjected to Radiation for purposes of Palliation.
- *Subgroup A:* Cases treated with Cauterization and Radiation.
- *Subgroup B:* Cases treated only with Radiation.

GROUP 5. Carcinomata that recurred after a Panhysterectomy.
- *Subgroup A:* Local recurrence.
- *Subgroup B:* Regional recurrence.

TABLE II. TOTAL NUMBER OF CASES IN EACH GROUP AND GROSS RESULTS.

Group	*Total Number*	*Living*	*Dead*	*No Report or Refractory*
1 *A*	3	3		
1 *B*	11	9	2	
1 *C*	1	1		
Total	15	13	2	
2 *A*	13	5	5	3
2 *B*	9	7	2	
Total	22	12	7	3
3 *A*	16	2	10	4
3 *B*	25	4	9	12
3 *C*	41	18	11	12
Total	82	24	30	28
4 *A*	6	1	1	4
4 *B*	33	6	16	11
Total	39	7	17	15
5	50	9	16	25
Grand Total	208	65	72	71

cases within the near future. The object of bringing these cases to your attention at this time is to request you to report similar observations and thus contribute to the solution of many disputed assumptions.

CONCLUSIONS

1. Statistics of uterine carcinomata treated by radiation can be of value only if based on a proper grouping of such tumors.

2. The indications for the various modes of technique of treatment with radium, also, must be based on such a grouping.

3. The evolution of a correct and efficient technique is solely dependent on anatomical, biological and clinical observations.

This paper is offered to the American Radium Association to invite liberal criticism and to stimulate the efforts to develop radium therapy into an accurate and standardized science.

TABLE III. TIME ELAPSED SINCE TREATMENT IN CASES KNOWN LIVING OR DEAD OF GROUP I.

Subgroup A					*Subgroup B*					*Subgroup C*				
Living		*Dead*		*No Report or*	*Living*		*Dead*		*No Report or*	*Living*		*Dead*		*No Report*
Yrs.	*Mths.*	*Yrs.*	*Mths.*	*Refractory*	*Yrs.*	*Mths.*	*Yrs.*	*Mths.*	*Refractory*	*Yrs.*	*Mths.*	*Yrs.*	*Mths.*	*Refractory*
5	6				5			3		2	7			
4	11				5			4						
2	10				4									
					2	7								
					2	7								
					2									
					1	7								
					1	5								
					1	1								

TABLE IV. TIME ELAPSED SINCE TREATMENT IN CASES KNOWN LIVING OR DEAD OF GROUP 3.

Subgroup A					*Subgroup B*					*Subgroup C*				
Living		*Dead*		*No Report or*	*Living*		*Dead*		*No Report or*	*Living*		*Dead*		*No Report or*
Yrs.	*Mths.*	*Yrs.*	*Mths.*	*Refractory*	*Yrs.*	*Mths.*	*Yrs.*	*Mths.*	*Refractory*	*Yrs.*	*Mths.*	*Yrs.*	*Mths.*	*Refractory*
	11		3	4	1	2	1	2	12	2	8		8	12
	9		2		3	3	1	8		1	8	2	10	
			5		4			2		1	4		8	
			5		2	6	1	6		1	4		2	
			5					3		1	4		8	
			7				2	1		1	2	1	4	
			1				1	9		1			9	
		1	1					6		1		1	3	
			9					10			11	1	3	
			7								10		10	
											9		21	
											9			
											8			
											6			
											6			
											6			
											4			
											4			

TABLE V. TIME ELAPSED SINCE TREATMENT IN CASES KNOWN LIVING OR DEAD IN GROUPS IV AND V.

Subgroup IV A					*Subgroup IV B*					*Subgroup V*				
Living		*Dead*		*No Report or*	*Living*		*Dead*		*No Report or*	*Living*		*Dead*		*No Report or*
Yrs.	*Mths.*	*Yrs.*	*Mths.*	*Refractory*	*Yrs.*	*Mths.*	*Yrs.*	*Mths*	*Refractory*	*Yrs.*	*Mths.*	*Yrs.*	*Mths.*	*Refractory*
2	9		1	4		10		4 days	11	3	9		8	25
						7		4		1	10	1		
						5		2		1	4		3	
						3		5			9	2	6	
						3		5			10		11	
						2		7			10	1	7	
								2			7		6	
								2			3		3	
								2			3	2	3	
								4 days					8	
								5					6	
								3 days					3	
								8 days				1		
								11					5	
								6 days					12 days	
								6 days					2	

DISCUSSION

Dr. William Kohlmann, New Orleans.—It was a pleasure to me to be invited here to listen to these interesting papers. There is no doubt that they are very important and very interesting to me. We all know that radium is a new remedy in the treatment of uterine disease. The application of radium to uterine fibroids and in menorrhagia is very simple, and applied to the cervix and in the vagina is always more or less a success. Not every case can be treated by this method, just as with roentgen rays. In my experience in working with these cases, I have always followed the following rules: Large fibroids are always followed by surgery, yet I believe they could be treated with radium. In small fibroids, of course, it is difficult, especially if they are small and multiple. We are then often up against a differential diagnosis, and in some of these cases radium does not work. Under such conditions, I have usually followed these rules; but when I was doubtful, and if one application of radium did not give me any success, I have opened the uterus by vaginal hysterotomy. This operation produces less traumatism to the patient than that referred to by Dr. Stacy. One reason why I do this is because I have recently seen a number of old ladies, beyond the menopause, who began to bleed and who had symptoms of carcinoma, and only after the hysterotomy did I discover that they had polypus, and this would not be relieved by radium.

A more important thing is the question of treatment of cancer. Is radium the remedy we think it is, that we can rely upon in the treatment of uterine cancer as we do now? Years ago I was a believer in the operation, but our results were very bad. I have only one patient who is living. She was operated in 1913 and now has a recurrence, and probably will not live very long. When radium first came into use I was surprised at the effect that a few milligrams would have, and I was encouraged to think that radium would be the treatment of choice. After this I gave up operating entirely, for if we remove the uterus the growth returns anyway. About two and one-half years ago I started to treat early cases with radium, and I have three cases now that are practically well. In one, no radium has been used for a year and the patient is practically well. In the advanced cases, patients become comparatively well. They may have recurrences, usually after eight or nine months, and in these cases they are bound to succumb eventually. I have some statistics that are very interesting: Three early cases are living; of five cases operated in

which the operation proved very difficult, there are 20 per cent living; and in twenty inoperable cases two are living. It is really remarkable that the inoperable cases should be living after this. That means, I think, that we should treat all cases in this way. In the early cases, I have used three applications, as a rule, of 75 milligrams, and these have been satisfactory. The disease has disappeared microscopically, examination has shown the uterus to be free and the patients are living. A good many patients do well after radium, but some growths will not yield, or they recur very early.

It came to my mind that I might treat these cases in the same way as suggested by Clark, who combined this treatment with the Percy cautery, to ligate both internal iliac and ovarian arteries. I have followed this example and have now operated fifteen cases and they have done very well. I do not curette the cervix, but merely apply the radium. After the first application the growth disappears, after the second, it is possible to apply the radium to the cervix. In that way, I usually make three applications, let the patient go home, and then return within six weeks to three months. Only recently, I have taken up the plan of Janeway, and have one case in which I applied one dose of 150 milligrams, then a ligation of both iliacs and both ovaries, and within a week I also applied 100 milligrams for twenty-four hours after that. The cervix is clean, and the patient returned home within the week. Janeway speaks very well of the large amount of radium applied over a longer time, and my results in this way have been very satisfactory.

Dr. George E. Pfahler, Philadelphia.—I am sure we all appreciate this excellent symposium. These papers are all prepared by investigators who are recording their results very accurately, and I think this is an opportunity to adopt, as Dr. Skinner has already suggested to me, the outline which Dr. Schmidt has prepared for the classification of cases. It seems to me that if such an outline was prepared by the Society and sent out by the Society we should soon accumulate some statistics along this line that would be of real value, provided, of course, that their records are made in a scientific manner.

In regard to the application of radium in carcinoma of the cervix and uterus, I believe if we are careful to keep the bowels and bladder empty during the application of the radium that we will help to avoid irritation of the rectum and the bladder. In some recent cases I have been keeping a catheter in the bladder in order to keep it empty continuously and of course the bladder is thereby contracted away from the uterus, and in that way is more protected from the radium. Distance is our greatest protection from radium, after all.

Another thing that I think should be more emphasized in the papers that have been presented is the combined action of radium and roentgen rays. Whatever can be accomplished by radium, it can be supplemented by roentgen rays. We are not interfering with the action of the radium, and if in addition we can add what benefits have already been produced and have been proven from the roentgen rays alone through the abdomen, there is no reason why we should not add these benefits. I think every one here will acknowledge that you can produce more results from the Coolidge tube applied through the abdomen than you can with radium applied through the abdomen, at least in the amounts that most of us have. That same thing can be continued in the treatment of fibroids of the uterus. We hear a great deal now about limiting the application of radium in the treatment of fibroids of the uterus to the small growths. Undoubtedly you will get the best results, but there are certain contraindications to operation even on large fibroids, and we shall get a number of patients that we would rather not have operated upon to whom we can still offer hope of cure by means of the roentgen rays applied through the abdomen and radium in the uterine canal. I have had a number of cases sent to me by gynecologists as inoperable, for treatment by radiation, in which the fibroids were very large—fibroids that came well above the umbilicus, and I have been able to get rid of them. Perhaps we cannot expect radium to do that because the results obtained by radium are limited chiefly to a few centimeters from the radium. Dr. Schmidt extends it to six, and I know of no one who goes above that; but in the fibroids going above the umbilicus you are not getting much action from radium applied to the cervix. You will not get as good results from the radium alone, but the large fibroid is very easily reached with the roentgen rays, and you

have a good big surface from which you can cross-fire. So let us get as much from each agent as possible, and let us combine them and therefore get more than we can get by either agent used alone.

Dr. Albert Soiland, Los Angeles.—I have enjoyed this symposium very much, and think it is one of the most valuable that I have ever had the privilege of listening to. It was very interesting to hear from Dr. Stacy that the Mayo brothers are willing to submit such a large number of patients to radium. It is just a few years that they have been using radium and the results are remarkable. I presume that in a future paper Dr. Stacy will extend materially the scope of this work.

Dr. Skinner's paper appeals strongly, for we feel that before the days of radium we had accomplished considerable good work with roentgen rays alone, not only with the large fibroids, but with metrorrhagia. We were successful in many cases in producing symptomatic cures. Now with the addition of radium to these cases, which can so readily be applied, results are more rapidly attained. As time goes on we can see that the roentgen ray men are becoming radium users to a great extent. I wish to compliment Dr. Skinner in applying the maximum amount of radium to the tissues with the minimum amount of danger.

Dr. Schmidt presented his paper in a very scientific way. I have kept two or three of his former suggestions, and will attempt his method of seven day treatments. I have been using the three period treatments, one treatment every other night, but will now try his seven day method and if it proves better than our present technique we will adopt it.

It is interesting to observe that radium is displacing surgery in many troubles within the female pelvis. I have always wondered why so many contraindications are given for ray treatment to pelvic conditions. I do not believe there is any contraindication, unless it is sepsis or a case which is so rapidly advancing that it must have immediate operation to save life. Of course, in a clearly surgical case, radiology is only to be considered as a supplemental agency.

Dr. Leda J. Stacy, Rochester, Minnesota.—I have nothing further to add except in reference to Doctor Pfahler's remarks. We do use the roentgen tube in the treatment of large tumors. In the contraindications, I think we should recognize chronic infection as a very definite one which might be lighted up by the radium treatment.

THE OCCURRENCE OF INTESTINAL TUBERCULOSIS IN PATIENTS WITH PULMONARY TUBERCULOSIS AT THE TRUDEAU SANATORIUM*

By LAWRASON BROWN, M.D., HOMER L. SAMPSON and F. H. HEISE, M.D.

TRUDEAU, N. Y.

A RECENT study of intestinal tuberculosis by two of us has led us to believe that it can now be diagnosed in many instances long before symptoms formerly considered characteristic of it appear. With such a method at our disposal we began to study to see when it first appeared in the course of pulmonary tuberculosis. It was but natural that a routine examination of all patients admitted to the Trudeau Sanatorium should be undertaken by this roentgenologic method, and we wish now to report on 89 unselected consecutive cases. At the same time we submitted 80 of them to a carmine test to see if it would reveal hypermotility if present.

BARIUM MEAL TECHNIQUE

The barium meal technique differs slightly from the one mentioned in a previous communication [1] in that the patients are exam-

*Published simultaneously in the *American Review of Tuberculosis.*

ined more frequently. The examination was mainly roentgenoscopic. However, plates were made at frequent intervals in many cases in order to check or clarify doubtful observations. For the thirty-six hours prior to the ingestion of the barium meal usually given at 9 A. M. the patient abstains from the use of any laxative. Breakfast was permitted. The ingestion of the barium meal was observed roentgenoscopically. Following the ingestion, examinations were made at two-hour intervals for the next ten hours or oftener if the case warranted it. Dinner was omitted. The patient was then examined every twenty-four hours until there was a complete elimination of the barium. In some cases of marked constipation the patient took a laxative after the seventy-second hour examination. This was done to give him relief.

RESULTS OF BARIUM MEAL STUDY

Immediately following the ingestion of the barium meal nothing of importance was observed in any of the cases. The different types of the stomachs varied from hypertonic to atonic and the position (height) was also a very variable factor. In some of the cases extreme ptosis was observed. The cap or first portion of the duodenum was seen at this examination or the next in practically all the cases.

The two-hour and four-hour examinations revealed the usual or "normal" picture. However, the latter possibly threw a little light on the question of tuberculous enteritis, whereas in many of the cases previously recorded [1] we had observed marked segmentation of the ileum with apparently localized stasis and dilatation; this was rarely observed in the present series of routine cases. These manifestations, it would seem, deserve further and closer study.

In 11 cases (12 per cent) a gastric retention was observed at the eighth hour. From observations previously made [1] the impression was formed that gastric retention occurred more frequently in patients suffering from proved intestinal tuberculosis than in those apparently negative. However, the manifestations should not be given too much weight in the present series as only 4 or probably 6 cases were diagnosed positive.

Considerable time and effort was spent on the examinations from the sixth to the ninth hour with more frequent observations in the suspicious cases, for during this period the roentgenological interpretation of tuberculous colitis can practically always be made. However, other factors contribute materially to the final diagnosis. In 83 cases (93¼ per cent) no definite filling defects were observed in the proximal half of the colon if enough barium had reached these sites to over-fill them. The colon was usually well rounded and decided haustration was commonly seen in a large number. Attempts were made to test the excitability of the cecum and ascending colon by trying to cause this portion of the bowel to eliminate the barium it contained. This was done by moderately deep palpation. The attempt, however, was unsuccessful. It may be recalled here that the opposite is true in a majority of cases suffering from tuberculous colitis, i.e., slight stimulation by palpation causes emptying of the cecum. Complete elimination of barium occurred in the negative cases at varying times between twenty-four and one hundred and twenty hours. However, two cases did reveal a barium-free bowel at the twenty-four hour examination. The great majority eliminated the barium completely between the forty-eighth and seventy-second hour.

Four of the remaining 6 cases presented an entirely different picture—either absence of the cecal or ascending colon shadow at that time (sixth and eighth hour) when more than enough barium to fill these sites had passed, or decidedly defective filling of these parts occurred with considerable barium beyond this point. In two or three of these positive cases barium could be seen in the terminal ileum at the sixth hour examination, while one-half an hour to an hour later it was apparently in the transverse and descending colon, indicating a probable site

of irritability in the ascending colon. In these 4 cases complete elimination of barium occurred in twenty-four hours. The 2 remaining doubtfully positive cases presented manifestations somewhat similar to the positive cases but not characteristic enough to warrant their inclusion in the positive group. Further examination is always indicated in this type of case.

In the previous study we were impressed by the rapid complete elimination of barium from the colon, which very commonly occurred in less than twenty-four hours; and hoping that the ingestion of carmine would throw further light on the question of hypermotility in tuberculous colitis, we started to examine routinely 100 cases at the Trudeau Sanatorium.

CARMINE TEST TECHNIQUE

To determine the motility of the gastrointestinal tract, eight hours following the last defacation the patient was given two carmine capsules (5 grains each), following which the appearance and disappearance of the carmine in the stools were noted. No modifications were made in the patients' daily routine other than that they were to abstain from the use of any laxative.

RESULTS OF CARMINE TEST

In 50 cases (62½ per cent) the carmine appeared in the stools between the eleventh and eighteenth hour, occurring most frequently at the sixteenth hour (16 cases). The time of appearance of the 30 remaining cases varied between eight and sixty-four hours. The time of disappearance varied between twelve and one hundred and thirty-five hours, complete elimination occurring in 34 of the cases (42½ per cent) between the thirty-fifth and forty-ninth hour. In 5 cases the carmine was recorded as having disappeared in less than twenty-four hours. Of these only 2 were diagnosed as having tuberculous colitis. As far as the "time of appearance" is concerned no important features were brought out.

It would appear from the above data that the time of appearance of the carmine which occurred in 50 of the cases (62½ per cent) between the eleventh to the eighteenth hour was the result of taking the carmine at a specified time, namely eight hours after the last defecation, whereas the time of disappearance was not so well controlled.

SUMMARY

In this series of 89 consecutive routine examinations tuberculous colitis was diagnosed as positive in 4 and as doubtfully positive in 2. Thirteen per cent of the patients at the Trudeau Sanatorium are discharged unimproved.

The use of carmine is of no help in determining the presence of hypermotility in tuberculous colitis.

[1] Brown and Sampson. The Early Roentgen Diagnosis of Ulcerative Tuberculous Colitis. *J. Am. M. Assn.*, July 12, 1919, lxxii, 77-85. Am. J. Roentgenol., Dec, 1919, vi, 625-640.

LETHAL AND ERYTHEMA DOSAGE OF RADIUM IN MALIGNANCY

By RUSSELL H. BOGGS, M.D.

Roentgenologist, Allegheny General Hospital; Dermatologist and Roentgenologist, Columbia and Pittsburgh Hospitals

PITTSBURGH, PA.

THE lethal dose in the treatment of malignancy by radium is the most important subject under discussion at present. Many are collecting data and attempting to compile statistics, but unless they know the amount of radiation necessary to eradicate the different types of malignant cells and are able to compare this amount with the erythema dose, no definite information can be obtained. The conflicting reports regarding results are largely due to the radiotherapeutist's failure to recognize the amount of radiation normal tissue will safely tolerate, as well as the susceptibility of the various tumors.

The term erythema dose is a very loose one and does not mean exactly the same intensity of effect to different radiologists when applying radium or the *x*-ray. This term used by one radiologist means a dose which causes no visible reaction, when used by another it means an erythema followed by slight desquamation, while by others it means an erythema followed by more marked desquamation or even vesiculation. The erythema effects produced by varying types of radiant energy, such for example as beta and gamma rays from radium and the filtered and unfiltered *x*-rays, vary widely due to the different fractions of the rays, in part absorbed in the skin, and to the varying depth that effects are produced. It is safe to give a marked reaction, followed by a desquamation, in treating small skin areas, but when large surfaces are exposed, the same intensity must be given with caution. The pastille erythema dose is very unreliable and is not to be relied upon any more than the milliampere minute dose, different types of transformers being used. Therefore there has been much confusion when different radiologists speak about an erythema dose. An electroscope is the only accurate means of measuring exact dosage, but this is not practical except in scientific laboratories. In comparing the erythema and lethal dose, exact standards should be employed. Conclusions based upon false assumptions have been very misleading. It is a well known fact that skin and mucous membrane reaction varies in different parts of the body.

The histological, physiological and pathological actions of radium have been studied ever since the rays have been employed, and the manner in which different tissues respond is fairly well determined, but sufficient attention has not been paid to the difference between the lethal and erythema dose. It has been known from the beginning that the dose to destroy different types of cells varies greatly, that is, glandular cells will be destroyed by a dose which does not harm cells of connective tissue; the mucous membranes, except the vagina, are much more sensitive to radiation than the skin; and rodent ulcer or basal-cell epithelioma and lymphosarcoma are destroyed by much less radiation than other types of malignant growths. Many fail to realize that the lethal dose for most of the other types of cancerous growths is from three to six or seven times this amount. This has accounted for the fallacy that squamous cell epithelioma could not be cured by radium or the *x*-ray. Most of the small rodent ulcers can be cured by an almost invisible dermatitis, but this amount has very little curative effect on a squamous epithelioma of the lower lip, but it will respond to a marked reaction if a radium tube is placed on the top, inside and

*Read at the Fifth Annual Meeting of THE AMERICAN RADIUM SOCIETY, New Orleans, La., April 26, 1920.

outside of the lip, thereby giving a lethal dose, or at least three times an erythema dose.

In a tumor that does not respond readily to radiation there is more necrosis and less absorption when a lethal dose is given. This is observed in treating sarcoma of the tonsil, the growth often disappearing before the reaction is marked, while a fibrosarcoma or chondrosarcoma which is more resistant will be unaffected by the same quantity of radium, and under intensive radiation necrosis may occur before absorption. Many of the metastatic nodules in skin of breast cancer will disappear with an erythema dose, and are often less resistant than the primary growth, while in a few instances these nodules require large doses.

Ewing claims: "In many cases of epidermoid carcinoma the disease is complicated by streptococcus infection of the tumor tissue, and this infection is very prone to extend wherever the tumor cells ramify in tissues or lymph nodes, and the symptoms of bacterial intoxication may dominate the clinical picture. In such cases the reaction to radium, even in palliative doses, is usually not favorable, because the radium inflammation renders the tissues edematous and seems to aggravate the infection. In fact it may be stated that the bacterial sterility of tumor tissue is a matter of first importance in radium therapy, and the presence of bacterial infection accounts for many radium failures, and often forms a contra-indication to its use."

Likewise, advanced syphilis or any disease that renders the patient anemic or lowers the vitality of the normal tissues further complicates the treatment. This is particularly noticeable in carcinoma of the tongue.

It is a fallacy to think that metastases in the lymphatic glands can be destroyed by a mild erythema dose or even less. One of our prominent gynecologists states: "It has been estimated that the normal cells are seven or eight times more resistant than some cancer cells, and considerably more than four times as resistant as the squamous type." It is hardly necessary to say that, by employing a technic built upon such principles, nothing whatever is accomplished in the treatment of the deep glands. He was producing his results entirely by the local use of radium. Attempting to cure malignant growths by giving only surface erythema doses in different radium institutes has accounted for the reports that epithelioma of tongue, tonsil and buccal mucous membranes did not respond to radium, while sarcoma of the tonsil readily disappeared, when the fact was that a lethal dose had not been given. This confusing an erythema with a lethal dose has accounted for the unnecessary and useless removal of epithelioma of the lower lip and other mouth cancers, together with the lymphatics, because surgeons have been led to believe that such lesions did not respond to radium.

No tissue is unaffected by radium, provided sufficient quantity is given, but every kind of tissue, both diseased and healthy, reacts in its own specific way. The dose required to destroy different types of malignant cells varies considerably, and this is further complicated when the growth is situated beneath the surface, and when deep-seated metastatic glands must be rayed. Glandular tissue is readily destroyed by the rays, but it requires more to destroy large lymphatic glands which have metastasized than the small glands of the skin. It is well known that it requires more radiation to destroy the hair follicles than to produce a temporary epiliation. The submaxillary gland is more resistant than the other glands in the neck; this may be due to its being more sclerosed from old irritation or its vascular supply.

The lymphatic glands which metastasize, often show an irregular response to radiation, some glands subside rapidly, while others respond slowly and require large doses before any noticeable reduction takes place. This is probably accounted for by the extent of the malignant and inflammatory products. Metastatic glands, made up largely of malignant tissue, respond more readily

than those composed principally of fibrous tissue. This shows the necessity of knowing the lethal dose. The fibrous formation, whether the result of nature's process, or whether formed by radiation, if carried out sufficiently, will cause a disappearance of the cancer cells.

Observations of the various multiple glandular tumors to radiation occur somewhat in the following order:

1. Simple, inflamed and enlarged glands, Hodgkin's disease, and lymphosarcoma, respond rapidly to a comparatively small amount of radiation. Recent enlargements, due to Hodgkin's disease, respond readily in comparison to older tumors composed largely of fibrous tissue.

2. Tuberculous glands, as a rule, subside more slowly and become quiescent under an erythema dose, but if of large size rarely entirely disappear. An erythema dose may be sufficient to cause the glands to undergo a fibrous degeneration with a disappearance of the tuberculous foci. It has been claimed that the lethal dose for tuberculous glands is one-third of that for carcinoma.

3. Carcinomatous glands require more radiation to destroy all cancer cells, although they may become quiescent and undergo a fibrous degeneration with less radiation than a lethal dose, but later become active again, unless the cancer cells are destroyed. The manner in which the glands are destroyed show that it is more difficult to give a lethal dose.

My clinical experience in regard to the lethal dose corresponds with the conclusions by Wood and Prime published January 31, 1920, which are as follows:

"Approximately four erythema doses of roentgen ray, given continuously and filtered through 3 mm. of aluminum, are required to kill mouse carcinoma, and five to kill mouse sarcoma exposed in vitro; but occasionally some cells may escape the effects of even six doses.

"Approximately six erythema doses of roentgen ray are required to kill sarcoma cells in vivo, as compared to five required to kill the same cells in vitro; and approximately six erythema doses are required to kill carcinoma cells in vivo, as compared to four required to kill the same cells in vitro.

"The basal-cell tumors and the lymphosarcomas are, as is well known, much more susceptible to radiation. Small, superficial metastatic carcinomas are also, in some instances, more susceptible than is the primary tumor."

It is to be remembered that Wood and Prime are speaking of only the direct action of radiation on malignant tissue; but there is an indirect effect of radiation on malignant cells by the formation of fibrosis which starts in to form three or four weeks afterwards. Both are important, and a lethal dose should always be given whenever possible; but less than a lethal dose sickens malignant tissue, as Mayo expresses it, and starts the formation of fibrous tissue which is a barrier against the disease. At present, by burying radium needles, a lethal dose can nearly always be given, but in the treatment of deep metastatic glands we may be compelled to depend upon both the direct and indirect effect of radiation on malignant cells.

In a paper, "Radium in the Treatment of Carcinoma of the Cervix and Uterus," read before the Eastern Section of The American Roentgen Ray Society, January, 1920, I discussed the difference between the erythema and lethal doses of radium and the roentgen rays. An attempt was made to show that many were treating the local growth efficiently, but only a small number of these realized the difficulty in treating the metastatic lymphatics in the pelvis.

Eradicating every malignant cell is difficult, no matter how thoroughly the method employed is carried out. Most radiologists and surgeons formerly were satisfied with the removal of the visible part of the disease. It is true that the cancer-growing edge, although inappreciable by ordinary methods of examination, is just as definite as ringworm. If the local growth be removed either by surgery or by radium, leaving a cancer-growing edge, the patient will not be

cured. Cutting out the center of a malignant growth usually hastens metastases because it removes the natural local barriers. Ante-operative raying is being advocated by some and may be even more valuable than post-operative. Even if a lethal dose cannot be given, the treatment may be sufficient to check, temporarily, proliferation and make the lymphatics a stronger barrier against cancer cells when operation is performed. In fact, it would seem that ante-operative raying renders many cases of malignant growths latent.

William J. Mayo, in his presidential address before the Clinical Congress of the American College of Surgeons, October 20, 1919, advocated ante-operative radiation in the following words:

"Radiotherapy has justly achieved a reputation in the postoperative treatment of cancer. It would appear, however, to have its greatest field of usefulness in preparing a malignant area against wound-grafting during operation and its ability at least temporarily to reduce the vitality of the malignant cell. Radiotherapy, whether applied as radium, *x*-ray, or heat, sickens malignant cells beyond the area of destruction. During this period of cell sickness their resistance is reduced and operation is most efficient, but operation should not be delayed after radiotherapy, since the period of increased cell vulnerability is short and the connective-tissue development, which interferes with subsequent operation, is rapid. By properly combining radiotherapy with surgery, we can increase operability, lower mortality and increase percentage of cures.

"Radiotherapy destroys for a certain distance, but cells are sterilized at a greater distance so that their reproduction is checked, and connective tissue is caused to develop which acts as a barrier to the further extension of the malignant process."

It can be readily seen that Mayo appreciates both the direct effects when a lethal dose is given, and also the indirect or late effects of paralyzing or making the cancer cells retrogress, together with the connective-tissue formation which has a choking effect on the cancer cells.

The ability to classify the cases forms an important part of the training of the radiologist. The question of large dosage altering normal tissue after the reaction has disappeared is well known and this alteration of tissue will not permit the normal tissues to bear so well a second exposure. The normal tissues are usually more easily injured by a repetition of the radiation, while the cancerous tissue may not retrogress in a proportional degree. In fact, the cancer cells and normal tissue may react in about the same degree, or there may even be a reversal of the primary susceptibility of tissue. This suggests giving the maximum dosage at the first treatment and the removal, either surgically or by electro-coagulation, of the overlying normal tissue, which has reached ray toleration, before more treatment is given.

From what has been said it can be readily seen that the treatment of even rather superficial lesions is a complex problem when the lethal dose of radium varies from an erythema reaction to from three to six or seven times this amount, more so if the growth is situated in normal tissue which does not stand large doses of radiation. This is further complicated if it is in a functionating organ or a deep-seated growth or in deep metastatic glands, because the filtration, distance and number of ports of entry or amount of crossfiring as well as the intensity of the radiation and time of exposure must be calculated. It makes quite a difference whether the area under treatment is situated one-half or four inches from the surface. Formerly, those applying both radium and the roentgen rays paid very little attention to loss of radiation by divergence of the rays, or by absorption in the tissues. They seemed to think because radium will penetrate thick metals or because a roentgenogram could be taken of thick parts, the penetrating power was all that was needed. Therefore, a greater number of those applying radiotherapy gave a surface erythema

dose, and when the radiation had reached the proper distance below the surface of the skin, they had only given a fractional part of a lethal dose. In many instances the local growth was treated efficiently, but inefficient radiation has often been given to deeply situated growths and to the deep lymphatic glands.

My own experience leads me to prefer the use of radium in the treatment of the more superficial malignant tumors and glands; but by using sufficient number of portals, the x-ray is to be preferred to control deep-lying malignant cells. (See "Radium in the Treatment of Carcinoma of the Cervix and Uterus," referred to above.) It would seem that a more satisfactory way to influence these growths favorably would consist in opening up the field and inserting into the malignant growths radium or emanation needles. This more direct attack of the problem has the advantage of offering a better utilization of the rays, since a much smaller quantity of radium is needed, and at the same time, there is not the danger of untoward action on normal tissues which is encountered when deep-lying growths are treated by heavy crossfiring through considerable thickness of normal tissue. As yet there is not sufficient evidence available to make it possible to determine the value of embedded needles in such conditions as the malignant extensions in carcinoma of the cervix, and we can only suggest that for such growths, requiring as they do rather large dosage, this method of treatment would seem to be the most desirable. However, surface application will have a place in the treatment of the invisible and impalpable glands, even if radium is embedded.

A circular letter on this subject was sent to radiologists using radium needles, but the divergent answers received made it practically impossible to draw any general conclusions. The time of exposure and the distance of the needles apart vary considerably, but nearly all agreed that embedding radium in malignant tissue was superior to surface applications in many situations. Some place the radium needles 1 centimeter apart, while others used a distance of 2½ centimeters between the needles. One operator gave from two to three hours of exposure while others gave from twelve to eight hours, using the same amount of radium element, and practically nothing was reported in regard to the reaction in the tissues. When you consider the essential unsatisfactoriness of hasty and brief replies to a circular letter, especially when dealing with such a complex subject, it is distinctly gratifying to find such general approval of a method, and I may say that my own work with embedded needles was taken up most reluctantly; but I can now endorse this technic as presenting many points of advantage over surface applications in the treatment of many forms of malignant lesions. I have adopted as standard in the tongue or tonsil placing ten milligram needles 1 centimeter apart, and have been giving from three to eight hours' exposure. This produces some inflammatory reaction, but in no case has marked necrosis taken place, except in some of the cases situated on the buccal mucous membrane where the tissue was about to break down or had broken down before treatment was begun.

I have felt from the beginning that there was danger of spreading metastases in distant glands by burying radium, and for this reason have nearly always given surface applications of radium two weeks before inserting the radium. If the reaction has been marked, it may be advisable to use electrocoagulation, particularly if the lesion is situated on the cheek or tongue; but undoubtedly in the tongue cases it is always preferable to insert radium needles into healthy zones surrounding the lesion before electrocoagulation is used.

In conclusion, the importance of a lethal dose in malignancy cannot be too strongly advocated, but that there is an indirect effect by less dosage must always be remembered. The formation of fibrous tissue is important since it cuts off the nourishment from the cancerous cells. The defensive cells

of the body have a tendency to destroy carcinoma cells. The first effect of radium is on the cancer cells, checking cell division; later it is followed by changes in the parenchyma and the stroma of the tumor tissue. After treatment there is always primary parenchymatous destruction with secondary replacement of the destroyed tumor cells by the ever-increasing stroma.

It is generally conceded that when more than one lymphatic chain is involved at the time of operation, the patient is not cured surgically, and that many of these cases can be clinically cured by radiotherapy because cancer cells can be destroyed by radium which cannot be reached by the knife. Hence the importance of giving a lethal dose becomes apparent.

CASE SHOWING VALUE OF THE X-RAY IN UROLOGICAL DIAGNOSIS

By G. FRANK LYDSTON, M.D.

Formerly Professor of the Surgical Diseases of the Genito-Urinary Organs and Syphilology in the Medical Department of the State University of Illinois.

CHICAGO, ILL.

THE *x*-ray as an aid to diagnosis has nowhere proven more valuable than in the field of urology. It is true that we often made accurate diagnosis of bladder stone long before the *x*-ray was discovered, but we often "fell down," and in many cases in which we did not, the diagnosis was established only at the expense of much time and trouble and considerable punishment of the unfortunate patient. Positive diagnosis of renal calculus was not possible until the advent of the *x*-ray.

Intolerant and bleeding bladders and urethral obstructions often have defeated us, even in the use of the cystoscope. Not infrequently, stones have been overlooked by the cystoscopist. Where the *x*-ray is available, an accurate diagnosis nowadays is almost always possible, if the roentgenologist is competent. The following case is decidedly in point:

A man of forty had suffered from severe bladder symptoms for five or six years. The symptoms recounted were typic of vesical calculus, but because a prostatitis existed and there was a history of gonorrhea, the patient had suffered from many massages and innumerable irrigations from divers physicians.

The bladder was intolerant of fluid and bled readily on instrumental manipulation, hence cystoscopy was not available. The

FIG. 1. SHOWING LARGE VESICAL CALCULUS.

x-ray beautifully showed the presence of a large vesical calculus. The author removed the stone by suprapubic cystotomy, with complete relief of all the urinary symptoms. The urine remained cloudy for several months, but finally became normal.

RADIUM IN TOXIC GOITER*

By W. H. B. AIKINS, M.D., C.M., L.R.C.P. (Lond.).

Consulting Physician, Toronto General Hospital, Toronto Hospital for Incurables;
Past President American Radium Society, etc., etc.

TORONTO, CANADA

THERE are various names for this disease which include hyperthyroidism, Graves' disease, Basedow's disease, exophthalmic goiter, and toxic goiter. A very able argument urging the use of the term toxic goiter for the disease in question is given by O'Day [10]. To quote: "While hyperthyroidism is said to be a condition that is caused by an over-active thyroid gland, and toxic goiter one that imposes its baneful effects through a pathological secretion, our observations rather forbid the acceptance of such distinctions. We are, however, convinced that an oversecretion of the normal thyroid is toxic, but no evidence was found that a pathological secretion was sometimes the cause;" and again, "We will adhere to the term 'toxic goiter,' and then, keeping in mind that the thyroid is actually poisoning the body by an excess of its normal secretion, the resultant symptoms, including the exophthalmos should it appear, are to be regarded as the markings indicative of the course being taken by the toxicant." I am of the opinion of this writer that toxic goiter is the most satisfactory name for this disease.

It is generally recognized that the outstanding symptoms of toxic goiter are: (a) Extreme nervousness, which is evidenced by tremor and restlessness. (b) Disturbance of the cardio-vascular system, as shown by a very rapid pulse, high blood pressure, and tachycardia. (c) Ocular symptoms, including exophthalmos, Stellwag's and Von Graefe's signs; and (d) an enlarged thyroid gland. In some cases all of these features are present; in others some are absent; that is, there may be extreme nervousness with exophthalmos and no enlargement, or nervousness may be accompanied by an enlarged gland with no exophthalmos. The essential features of the disease are the symptoms of the cardio-vascular and nervous systems.

In a discussion of the mental condition of patients suffering from toxic goiter, Dieulafoy [5] says: "As a general rule, few patients escape psychical troubles. Boeteau thus describes the psychical troubles: 'The chief symptom is profound melancholy, which more and more enters into every one of the patient's thoughts, so that he entertains ideas of suicide. At the same time the victims become impatient, surly and remarkably emotional. Their will-power when not quite absent, is often very feeble; they are incapable of fixing their attention upon any subject, even for a minute; they cannot remember next day what they did the day before. They show complete indifference not only to what concerns them, but to everything which affects their family, even to those who are most dear to them; and this indifference may, sometimes amount to aversion.' "

One of the most striking features of advanced toxic goiter cases is their high blood pressure. It is suggested by Etienne and Richard,[6] of Nancy, that, in view of the close connection between the various endocrinous glands, this hypertension may be due to stimulation of the nervous system which affects the suprarenals, which are more exposed to it that the other endocrinous glands; there follows a hyper-secretion of adrenalin, determining an abnormal and permanent stimulation of the great sympathetic with consecutive stimulation of the thyroid and hyper-tension. Of all the physical signs of toxic goiter, there has been none that responded as well to radium as high blood pressure. Blood pressures of 200-230

*Read at the Fifth Annual Meeting of The American Radium Society, New Orleans, La., April 26, 1920.

mm. often drop 50 mm. in six weeks, and after a series of three or four treatments the result is practically normal.

ETIOLOGY

Very much has been written on the etiology of toxic goiter, and widely variant views of it are held. In the opinion of the writer there are three main causes: (a) the psychic causes, which include fear, shock, or other violent emotion; (b) infected foci, e.g., tonsils, adenoids, etc.; (c) hyperactivity of other endocrinous glands, present, for example, at puberty, pregnancy, or the menopause.

Many French writers refer to the frequency of cases resulting from a violent emotion or series of emotions in the army. Lian met with three cases in one group of artillerymen, the symptoms developing on their leaving a position which had been subjected to violent and prolonged bombardment. Merklen, Gallavardin and Lian suggest the probability of many of the cases of "Soldiers' Heart" being in reality latent cases of Basedow's disease. Very interesting instances, too, are cited by French writers of cases which occurred among civilians situated in the war zone. Etienne and Richard, of Nancy cite the following: A woman, aged nineteen, arrived at Royal in May, 1918, having experienced great emotion. There was bombardment immediately after her arrival, the next house being destroyed by an incendiary bomb. Menstruation, which had always been regular, and had commenced during the day, ceased. The pulsating thyroid increased greatly in size, and there was slight exophthalmos and irritability. After a month's rest there was recurrence of menstruation, improvement in the symptoms and reduction in the size of the thyroid.

Another interesting case is reported by the same writers in a subsequent article, of a case of Addison's disease which developed toxic goiter. A woman, aged thirty-six, in 1917, noticed bronze pigmentation of the skin; a diagnosis of suprarenal insufficiency was made and appropriate treatment given. She lived at Paris, but was so upset by an accident that she left within twenty-four hours for Royal. Four days after the accident the thyroid was seen to be large and pulsating, and there was acceleration of the pulse, slight tremor, but no marked exophthalmos. Physical and mental rest resulted in retrogression of the symptoms of toxic goiter, but death ensued later from Addison's disease, with manifest signs of suprarenal insufficiency.

Beebe [2] in discussing thyroid disease and the war, says: "The writer several years ago had as patients four men who developed severe hyperthyroidism during their experiences in the army serving in the Philippine Islands. They were in excellent health on entering the army and could definitely date their trouble to a particular campaign. Later, at the time of the Kishineff massacre in Russia, patients who had been subjected to the horrors of this experience came to New York with severe hyperthyroidism, the incidence of which they definitely dated from the fright and hardship they endured. The San Francisco earthquake produced similar cases."

In connection with the second cause, viz., that of infected foci, an interesting case is reported [9] of a woman who developed marked hyperthyroid symptoms with a pulse of 160. She refused thyroidectomy, but was willing to undergo an operation for an infected tonsil. After the operation she recovered and eventually regained perfect health. McCarrison [8] quotes Sir Arbuthnot Lane as having operated on a patient with a large goiter for constipation and as having obtained excellent results. The general symptoms improved, and there was a very distinct diminution in the size of the gland. These two cases are very interesting in that they emphasize the necessity for a very general examination of the patient, and especially the need for care of any infected organs, such as teeth, tonsils, etc.

Certain writers claim that focal infection produced by tuberculosis may play a large part in the etiology of this disease. Creyz [4]

quotes the theory of Poncet and Leriche in regard to the frequency of latent and inflammatory tuberculosis, and points out its relation to and influence on the development of toxic goiter. He cites a case of a woman, aged fifty-two, with no special heredity, except that one brother had died from pulmonary tuberculosis at the age of twenty-two. At the age of thirty she developed a simple goiter, which in the course of a year became as large as a small Tangarine orange, but has since remained stationary. In 1915 a shell fell near her house, and she experienced great emotion. On the following day there was slight hemoptosis, and her friends noticed her nervousness and the strangeness of her appearance. Symptoms of Basedow's disease became marked, and there were emaciation, cough, and spitting of blood from time to time. Her character changed to such a degree that she became intolerable to her family. In this case the toxic goiter developed on the basis of a long-standing simple goiter, but in addition there were typical symptoms of pulmonary tuberculosis.

The influence of hypersecretion of the ovaries on the secretion of the thyroid was taken up fully in a paper by the author [1] which was read at a meeting of this society held in June, 1918. Suffice it to say that there is very often a transient condition of hyperthyroidism at puberty, pregnancy or the menopause and that, in many instances, severe cases have their origin at these periods.

There are also many other interesting theories as to the cause of this disease. For instance, Sinclair [11] writes: "That amebic infection is the cause of goiter I have proved to my own satisfaction at least, and with the elimination of these amebae from the system the enlarged thyroid is restored to normal size."

It is difficult to estimate the importance of the old theory of the part played by water in the production of goiter. There is little literature in support of the view that toxic goiter is ever due to this cause. However, it is interesting to note that I have had several very advanced cases of toxic goiter from Manitoulin Island. In some of these cases the water may have produced a simple goiter and this has been followed by toxic symptoms.

When discussing the question as to whether the cause of the disease lies entirely in the thyroid, O'Day [10] says: "While the consensus of opinion holds the thyroid responsible, an embarrassing question may be interposed. It is this: Why do some of the distressing symptoms of toxic goiter frequently continue in some patients after the removal of each lobe?" He then cites five cases in which two, and in some cases three, operations failed to give the slightest relief.

An interesting case is cited by Lejars [5] of a girl of eighteen years who was operated on for exophthalmic goiter. The operation was successful and the patient rested well during the day. At 11 P. M. she was suddenly seized with intense dyspnea and considerable acceleration of respiratory movements. There was no flush of the face and no asphyxia, but she died in three-quarters of an hour. The autopsy gave no clue to the cause.

Poncet [5] gives the following opinion of surgery: "After various operations which I have performed in exophthalmic goiter, including simple exothyropexia, I have seen a fatal result. Such results, and also the frequent return of symptoms which had yielded for a very short while before the operation, have made me very circumspect. For my part, I shall not again meddle with the thyroid body in Basedow's disease."

Boggs [3] says that in relapses after operation for exophthalmic goiter radiation should always be employed after a careful study of the ductless glands has been made, rather than the contemplation of a second operation. I have had four cases who came to me after operation for goiter because the nervous symptoms had recurred. I had another patient who was dissatisfied with the progress she was making under radium treatment, and underwent an operation. Five months after the operation she returned to me, with extreme nervous symptoms, tachycardia and also ocular symptoms. She

has continued treatment with me, and, along with the cases above mentioned, is making satisfactory progress.

TREATMENT

An experience of twelve years has convinced me of the value of radium treatment. Four years ago I reported my results with 16 cases; in 1918 I gave a report on 45, and at the present time I am reporting from an experience with about 100 cases of this disease.

Concerning the treatment Robert Knox[7] makes the following statement: "In acute cases it has been found that treatment by radiations must be supplemented by (a) rest in bed, (b) dietetic treatment, and (c) treatment by drugs. The combined treatment is always more efficacious than either alone."

This practice has been followed in our treatment. Patients are urged to avoid all excitement, and to take as much rest as possible. They are also urged to eat very little meat, but to take plenty of other nourishing foods, such as milk, eggs, etc. The use of an icebag over the heart is recommended, capsules are prescribed containing quinine hydrobromate, grs. 5, t.i.d., together with ergotine, grs. 1, t.i.d. I also prescribe a mixture of strontium bromide with a bitter tonic and salines in the morning in order to ensure free elimination. In many cases the above treatment alone had proved inadequate, but when employed with radium it brought about improvement in the symptoms.

In applying radium over the thyroid gland, the effect required is one of deep penetration with a minimum skin reaction. In order to attain this result, the radium must be so screened as to prevent the action of the short but powerful beta rays, and to obtain the benefit of the more penetrating gamma rays.

The form of applicator which I prefer is large and flat. In some cases I have used tubes but I consider the flat applicators much more satisfactory. Those I use most frequently are 4 cm. x 4 cm., containing 10 mg. radium element, but I have two others which also give satisfaction, one 2 cm. x 2 cm., containing 10 mg. radium element, and the other 4 cm. x 2 cm., containing 5 mg. radium. The plaques are screened with two thin aluminum screens or one fairly thick brass one (about 0.8 mm.), with a layer of felt.

As a rule I make applications of three hours' duration, giving a first treatment of from 150 to 360 mg. hrs., depending on the degree to which the disease has advanced. I find it preferable to give smaller doses rather frequently than concentrated heavy dosage, as the latter is much more apt to cause systemic disturbances. The first treatment is usually completed in three days, and I leave an interval of about 6 weeks between applications. If the disease makes good progress, the second treatment need not be so heavy as the first. The quantity given in the second and subsequent treatments usually varies from 50 to 150 mg. hrs.

If the case is very far advanced, that is, if there is extreme nervousness and weakness, the patient is treated in a hospital, and the radium is left in position for long periods of time. Less severe cases are treated in the office for shorter periods of time.

Boggs in a paper on *x*-ray treatment of goiter, speaking of the type of goiter which occurs during adolescence, states that this type usually recover spontaneously, that if they do not, the value of the medical treatment is questionable, and it is not desirable to resort to surgery. He says that he undertook roentgen ray treatment reluctantly, merely to secure a cosmetic effect. He says: "I was amazed to find that the treatment resulted not only in a distinct gain of weight and bodily strength, but also in the correction of a psychic instability which has been looked on as a matter of character rather than disease. From frivolous, flighty, irresponsible girlhood the patient passed into serene, well-ordered womanhood. In other words, they were suffering from hyperthyroidism, in so slight a degree as to give no characteristic symptoms, yet sufficiently to affect both physical and psychic strength."

It is my opinion that the effect of radium in toxic goiter of adolescence has been in some respects similar to that produced by the *x*-rays, but that the former has many advantages. The superiority of radium treatment to that with *x*-rays is very well expressed by Dawson Turner,[12] when he says: "As compared with *x*-rays in the treatment of this condition, radium has the following advantages: (a) absolutely constant emission of rays, and therefore exact dosage possible; (b) far greater penetration of its rays, so that the deeper parts of the gland are reached; (c) no noisy exciting apparatus, so that the treatment can be applied at the bedside without in any way disturbing the patient. The words, '*cito, tuto, et jucunde*' * can fairly be applied to the radium treatment of exophthalmic goiter."

REPORTS OF CASES

Group A. Mild Toxic Goiter as seen in Adolescence

Case 1574. Miss B., aged fifteen, came to me in February, 1919. She showed some nervous symptoms and a goiter had been in evidence for about four months. She was given in all 464 mg. hrs. of radium, and when last seen she was in good health, but there had been little change in the size of the gland.

Case 1625. Miss K., aged fourteen, was first seen by me in April, 1919. A goiter had been present for four years, and it was gradually enlarging. She experienced distress in breathing, and tremor was present. She was given 753 mg. hrs. of radium. In July the tremor had disappeared, there was less distress in breathing, and less exophthalmos; also the measurement had decreased slightly. When seen in January, 1920, her general condition was very markedly improved.

Case 1707. Miss F., aged fifteen, began treatment in July, 1919. The gland was enlarged, giving a neck measurement of 13″ and 14½″; her weight was 107¾ pounds; the tonsils were somewhat enlarged. She was given 561 mg. hrs. of radium, and in January, 1920, she was in excellent health. The measurement had decreased to 13¾″ although there had been an increase in weight, and she now weighed 116 pounds.

* Quickly, safely and happily.

Group B. Grave Toxic Goiter with Enlarged Gland

Case 1128. Mrs. W., aged fifty-five, had had a simple goiter for seventeen years, and heart trouble had been in evidence for three years. She had received electrical treatment and had had a bad heart attack in April, 1917. When first seen her pulse was 132-140, blood pressure 170, neck measurements 12½″ and 14″ respectively, there were pressure symptoms, and her weight was 101 pounds. Treatment was begun in August, 1917, and she was given 1105 mg. hrs. of radium. By December she showed a pulse of 86, blood pressure of 140, and a weight of 114 pounds. In January, 1920, she reported that she was in excellent health and that then her weight was 125 pounds.

Case 1283. Miss M., thirty-five years of age, came to me in a very nervous condition, showing tremor and tachycardia with some exophthalmos. The neck measurements were 12″ and 14″, and the pulse 110. She began treatment in March, 1918, and in August the measurements of the neck were 12″ and 13½″ and the pulse was 72. There was no tremor and she looked and felt quite well. She received altogether 650 mg. hrs. of radium.

Case 1274. Mrs. D., aged forty-eight, began treatment in March, 1918. A goiter had been present for ten years with very marked nervous symptoms three years previously. The menopause had occurred in November, 1916. When first seen by me she showed much nervousness, mental excitement, tremor, palpitation, tachycardia, headache, and

nervous insomnia. The neck measurements were 13″ and 15½″. She received 733 mg. hrs. of radium, and when seen in September, 1919, she was in excellent health, there had been marked improvement in the symptoms and the size of the neck had decreased to 14½″ in the largest part.

Case 1213. This is one of the most striking cases of toxic goiter which I have treated from the point of view of the effect that the disease may produce on the mentality of the patient. The patient, Mrs. B., had been married for four years and had had one child. When she began treatment her mental condition was so far from normal that her husband was on the point of making application for a separation. She was extremely nervous, with much palpitation and exophthalmos. Her pulse was 120, and the neck measurements were 12″ and 13½″. She received in all 808 mg hrs. of radium. She began treatment in December, 1917, and when last heard from in November, 1919, her pulse was 62, and the eyes and heart were normal; her home life was normal and happy and she was able to do all her own work and also some outside work; she experienced no discontentment or melancholy.

Case 713. Miss W., aged forty-five, came to me in October, 1915. She had been in hospital the previous March and when first seen was extremely nervous; she complained of a sick nervous feeling. The pulse was variable from 68 to 120, and on exertion even 130; the neck measured 12½″ and 14½″; the left lobe of the thyroid was prominent; the eyes were prominent and easily strained; she complained of many headaches and her weight was 117½ pounds. In March, 1917, after she had received about 2000 mg. hrs. of radium, she seemed quite well. Her weight was 144, pulse 76, even and regular, the neck measurement had decreased slightly to 14″ and the eyes were much improved. The last time she was seen was in August, 1919, at which time she was still in excellent health.

Case 405. Miss K., aged twenty-one, consulted me in May, 1913. For a year she had been so nervous, excitable and changed in disposition, that her parents feared for her mental condition. When she first came under observation she was in a highly nervous condition, with marked tremor, cardiac rapidity, and enlargement of the thyroid, the circumference of the neck being 14 inches. She was given the regular treatment with radium, supplemented by rest in bed, an ice-bag over the heart, and the usual medicinal administration. Three months later the neck was only 12½ inches in circumference and the tachycardia and nervous symptoms had disappeared. In March, 1920, she was reported as being in excellent health, and living a normal life.

Case 611. A girl of nineteen presented a typical picture of toxic goiter. She began treatment in December, 1914. The thyroid was fairly prominent, the circumference of the neck being 14½″. There was well marked exophthalmos, the pulse rate was 120, and the patient was very nervous. No benefit had resulted from all ordinary measures of medical treatment, which had included the administration of hydrobromate of quinine and ergotin and of Moebius' serum, together with absolute rest for some months. She was kept in bed, and ice-bag was used, and the quinine and ergotin were continued. In April, 1915, the pulse rate had dropped to 76, tremor had disappeared, and the exophthalmos was scarcely noticeable. She has since married and now has one child. In September, 1919, she reported that she was enjoying perfect health. This case is especially interesting in that before the use of radium no improvement could be observed in the patient's condition, although she had been under treatment for two years with an excellent internist.

Case 1173. Miss M. came to me in October, 1917. In March, 1917, she had noticed pains in the back of her head; her tonsils were removed, but the pain remained. In

September she noticed a rapid pulse and nervousness, and was kept in bed for over a month; her neck measurement was 12″ and 13″, pulse 134 and weight 92 pounds. She was given 1000 mg. hrs. of radium up to July, 1918, and by April her weight was 108½ and her pulse 80 to 90. When seen in July, 1918, she was in excellent condition.

Group C. Grave Toxic Goiter with Little or No Enlargement of the Thyroid Gland

CASE 505. Mrs. K., aged thirty-five, came to me in February, 1914. She had suffered for five months previously from exophthalmic goiter, which developed six months after the removal of the ovaries. The thyroid gland was only slightly enlarged, but there was well marked tremor, and the pulse rate was 140. She had been treated at home by rest in bed, suitable diet and medication, together with other ordinary recognized methods of treatment, but without result. As a last resort she was sent to me for radium treatment. I prescribed absolute rest in bed with an ice-bag over the precordia, and the administration thrice daily of hydrobromate of quinine and ergotin. In addition heavy radiation was instituted over the thyroid. The improvement was marvelous. Within two weeks the pulse rate had dropped to 75, and the nervousness had almost entirely disappeared. The patient was kept under observation for six weeks, when she went home in apparently normal health. When seen again, about six months later, there had been no return of the symptoms of toxic goiter, and I am informed that she continues well.

CASE 1601. Mr. J., aged twenty-one, noticed the onset of exophthalmos and nervous symptoms in July, 1918; he suffered loss of weight; when seen in March, 1919, the teeth were in bad condition and tonsilitis was present, the follicles being filled with pus. His weight was 101 and pulse 150; there was very slight enlargement of the gland. He received a treatment of 360 mg. hrs. in March, and in May, after having the teeth and tonsils attended to, the pulse was 80, and the general condition was much improved. In August, after he had had a further raying of 255 mg. hrs. the pulse was 116, the exophthalmos still marked but lessened, Von Graefe's sign was improved, and his weight had risen to 121½. When last seen in December, 1919, his general condition was good, pulse was 90, and weight 121½.

CASE 1346. Mrs. O., thirty-six years of age, noticed a slight enlargement of the thyroid in December, 1917. She consulted me in May, 1918, in a very poor condition; she had been rapidly losing weight since December. Her weight in May was 83 pounds and her pulse 150; she received three treatments between May and August, and at the end of that time her weight was 110¾ pounds, and her pulse had fallen to normal. She was in good health when last heard from.

CASE 678. Mrs. C, aged twenty-seven. Protuberance of the eye-balls was first noticed after an attack of influenza in the spring of 1913, and subsequently there was dyspnea and palpitation. During the following winter the symptoms diminished somewhat in severity but after an attack of tonsilitis in March, 1915, she began to have attacks of vomiting, suffering from palpitation and she was very easily excited, the action of the heart becoming very rapid. In June, 1915, she was kept in bed for five weeks, when her pulse became normal. When seen in August, 1915, there was no enlargement of the thyroid, but the eyes were very prominent, and the pulse ranged from 84 to 120. Radiation was given over the thyroid, and in October she reported that she was very much better, the pulse was steadier, and she had gained in weight. In January, 1916, after further treatment, she was able to take short walks and do light housework without disturbing the pulse; nervousness had almost disappeared, and instead of having become a confirmed invalid she was now a

normal young woman. She received various treatment after the above date, and in March, 1920, she was in very good health.

CASE 1139. Miss E., aged forty, musician. In May, 1915, there was extreme exophthalmos with tachycardia and tremor; there was also mental unrest caused by overwork and nervous shock; the gland was very slightly enlarged. At this date she was ordered to have rest in bed, when sedatives were administered, followed by thyroid tablets, of which she took two to six daily, and she continued under the same physician until September, 1917, when she consulted me. When I first saw her the symptoms of toxic goiter were most marked, there was exophthalmos, a pulse rate of 130 and hypertension. After the application of radium extending over a period of three months normal conditions were restored, and at date of writing she enjoys most excellent health.

BIBLIOGRAPHY

1. AIKINS. Radiumtherapy in Hyperthyroidism with Observations on the Endocrinous System, *Canad. Pract.*, August, 1918.
2. BEEBE. *Med. Rec.*, Feb. 9, 1916.
3. BOGGS. AM. J. ROENTGENOL., 1919, vi, 613.
4. CREYX. *J. de méd. de Bordeaux*, 1918, lxxxix, 314.
5. DIEULAFOY. Textbook of Medicine, Vol. i, pp. 458 and 467.
6. ETIENNE et RICHARD. *Bull. et Mém. Soc. méd. d. Hôp. de Par.*, 1918, 3 s, xlii, 1196 and 1199.
7. KNOX. Radio-therapeutics, 468.
8. MCCARRISON. The Thyroid Gland, 52.
9. *Mississippi Valley M. J.*, October, 1918.
10. O'DAY. *N. York M. J.*, Feb. 14, 1920, p. 287.
11. SINCLAIR. *Am. Med.*, N.S., Dec. 1916, xi, 852-854.
12. TURNER. *Edin. M. J.*, February, 1919.

THE AMERICAN JOURNAL OF ROENTGENOLOGY

PUBLISHED BY PAUL B. HOEBER, NEW YORK CITY

Issued Monthly. Subscription, $6.00 per year. Advertising rates submitted on application. Editorial office, 480 Park Av., New York. Office of publication, 67-69 East 59th St., New York.

TWENTY-FIRST ANNUAL MEETING

The Twenty-first Annual Meeting of THE AMERICAN ROENTGEN RAY SOCIETY will be held at Rochester, Minn., and Minneapolis, Minn., September 14, 15, 16 and 17, 1920; at Rochester on the 14th, at Minneapolis on the 15th, 16th and 17th. Further details concerning the meeting will appear in these columns from month to month.

Meeting and exhibits will be held in the CURTIS HOTEL, Minneapolis, which can accommodate about 300 members and guests. Reservations should be made early.

For information regarding commercial exhibits, address Paul B. Hoeber, 69 East 59th Street, New York City.

LAST CALL FOR MINNEAPOLIS

The forthcoming meeting at Rochester and Minneapolis promises to be unique in the history of American roentgenology. Much new material is to be presented and discussed. We also have the added privilege of hearing what value the various specialists at the Mayo Clinic place on roentgenology, not only by formal papers, but by actual demonstrations in the various clinics. This latter feature alone makes attendance imperative. The Caldwell Memorial Lecture will be introduced. The subject is one of vital importance to all. The social features are an added interest, and all golfers are urged to bring their clubs to decide "Who's Who."

Travel arrangements should be made promptly. For detailed information on this subject, or if difficulty of any kind is experienced, Mr. A. C. Irons, General Passenger Agent Chicago Great Western Railroad Company, People's Gas Building, Chicago, Illinois, should be communicated with at once. In writing him state that you are attending THE AMERICAN ROENTGEN RAY SOCIETY meeting.

SPECIAL PLANS FOR ENTERTAINMENT OF LADIES

A committee of twenty-five Minneapolis ladies recently met at the home of Mrs. F. S. Bissell, to plan for the entertainment and comfort of visiting ladies during the coming convention. It is planned to keep them occupied in as pleasant a manner as possible most of the time. A special drive to various interesting points in and about Minneapolis and St. Paul, with a luncheon *en route* at the Minikahda Club, will occupy most of one day. Another drive for members and their guests, to end with a dinner-dance at Lake

Minnetonka, will be a feature of the first day. Plans also include a tour through the Minneapolis Art Institute and the Walker Art Galleries, with competent guides. Special headquarters will be maintained for the ladies during the three convention days.

* * *

Following precedent we are publishing in this issue the portrait of the President of The American Roentgen Ray Society, James T. Case, M.D.

CORRESPONDENCE

July 6th, 1920.

Dr. H. M. Imboden, *Editor,*
American Journal of Roentgenology,
480 Park Ave., New York City.

Dear Sir:

In your Journal for June, 1920, there appears an article, "The Diagnosis and Localization of Non-Opaque Foreign Bodies in the Bronchi," by Drs. Chevalier Jackson, William H. Spencer and Willis F. Manges, in which a claim is made for the discovery of three characteristic roentgenographic signs indicating the presence of non-opaque foreign bodies in the bronchus. These signs are enumerated by Dr. Manges, as follows: "1. Increased transparency over the entire affected side. 2. Depression of the diaphragm on the affected side. 3. Displacement of the heart and mediastinal structures away from the affected side—in short, an acute, obstructive emphysema."

I wish to call attention to the fact that I published two articles, one in 1911 and the other in 1912, both of which fully cover and explain the rediscovery announced in your Journal.

In explanation of the roentgenogram of a case with a peanut in the right bronchus, I made the following statement: "The physiological inspiratory expansion of the bronchus produced a valve-like action, admitting and entrapping the air beyond the foreign body, and this undoubtedly led to an emphysema of the right lung."

In describing the radiogram in another case where a peanut had lodged in the right bronchus and bronchiole, the following statement appears: "A radiogram by Dr. Lange revealed a shadow of less density over the right (affected side) than over the left lung. The right chest was somewhat larger (distended) than the left. The mediastinum was slightly displaced to the left."

One of the conclusions drawn in my publication of June, 1912, reads as follows: "Radiography is a great aid to the physical examination, and may show a marked difference in the two sides of the chest, even where the foreign body is of such a nature as not to show a shadow in the radiogram. In Case II, as explained in a previous paper on the subject (*Ohio State Medical Journal,* April, 1911), the foreign body must have acted as a valve, admitting air and leading to the over-distention of the lung on the affected side, as revealed by the radiogram."

I may further state that in a discussion of this subject before the American Laryngological, Rhinological and Otological Society, in 1917, I explained the same phenomena. Finally, Dr. Chevalier Jackson has quoted me on this subject in his last text book on Peroral Endoscopy, and at a recent medical meeting at Boston, he also credited me with having first pointed out the roentgenographic signs of a partially obstructing foreign body in a bronchus.

Kindly publish this letter in your Journal, in order that due publicity be given this matter.

Very truly yours,
Samuel Iglauer, M.D.

BIBLIOGRAPHY

Ohio State M. J., April, 1911.
Lancet-Clinic, June 1, 1912, cii, No. 22.
Tr. Am. Laryngol., Rhinol., & Otol. Soc., 1917, p. 177.

Philadelphia, July 16, 1920.

Dr. H. M. Imboden, *Editor,*
American Journal of Roentgenology,
480 Park Ave., New York City.

Dear Sir:

I wish hereby to acknowledge the claim of Dr. Samuel Iglauer as to his priority in the

discovery of the roentgenographic signs of acute obstructive emphysema in association with non-opaque foreign bodies in the bronchi, and their localization as well as diagnostic value.

I have had the pleasure of reading Dr. Iglauer's articles since receiving your letter. His statements in these articles as well as the roentgenogram illustrating one of them are very clear, and establish beyond any question his right to priority.

My portion of the article appearing in the June, 1920, number of The American Journal of Roentgenology loses its value as a discovery with the exception of characteristic sign 2, viz., depression of the diaphragm on the affected side. I consider this the most important of the three signs enumerated, for the reason that it is only by the depression and fixation of the diaphragm that we are able to differentiate roentgenographically between obstructive emphysema and compensatory emphysema.

In preparing the article for publication I did not review the literature on tracheobronchoscopy, and did not find any reference to Dr. Iglauer's work in the roentgenographic literature.

I regret exceedingly that I was not familiar with Dr. Iglauer's work before publishing my paper.

I shall accept every possible opportunity to give him credit, and I trust that you will give his letter the utmost publicity,

Very sincerly yours,

W. F. Manges.

Dr. H. M. Imboden, *Editor*,

American Journal of Roentgenology.

Dear Sir:

In the last issue of the Journal (June, 1920), there is an article on "The Diagnosis and Localization of Non-Opaque Foreign Bodies in the Bronchi," by Chevalier Jackson, William H. Spencer and Willis F. Manges, which especially emphasizes the importance of determining the presence of non-opaque foreign bodies in the bronchi, because of the marked pathological changes rapidly produced, and which is in marked contrast to the period of tolerance present when metallic foreign bodies are lodged in the bronchial tree. Under the heading of the roentgenological diagnosis, Dr. Manges skillfully describes the roentgenological signs of the resulting rapidly produced unilateral emphysema, which enable him to make the diagnosis of the presence of a foreign body without the foreign body itself being actually visible. May I point out that this is no new procedure? On several occasions in the last few years I have made a diagnosis of foreign body on this basis. The last instance was on November 29, 1919, in a child from the service of Dr. Coakley at Bellevue Hospital, under the care of Dr. Imperatori. The patient was sent to the x-ray department for an examination of the chest, because there

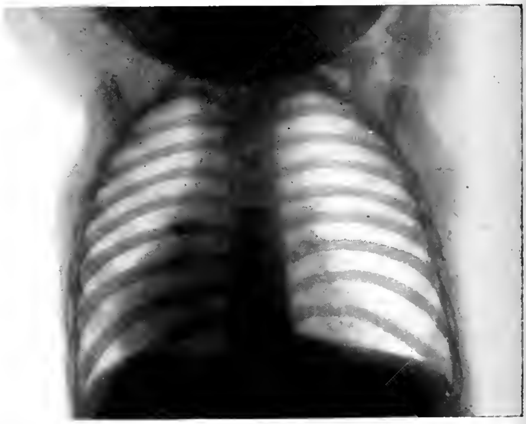


Fig. 1. Pl. A., No. 198535; Serial No. 48535. Nov. 29, 1919. Grape Stem in Right Bronchus. Radiograph four days after accident. The characteristic roentgen signs of unilateral emphysema are clearly demonstrable. 1. Brilliant illumination of the right pulmonic field. 2. Flattening of the convexity of the diaphragmatic outline. 3. Displacement of median shadow to the left.

was the clinical suspicion of a foreign body in the bronchus. On that day, on the basis of such signs (Fig. 1) as Dr. Manges has just discovered, I diagnosed the presence of a foreign body in the right bronchus. The next day Dr. Imperatori removed a grape stem from the right bronchus of the child.

In reference to the pathological concept of this condition, I desire to point out that

in an article on the Diagnosis of Foreign Bodies in the Alimentary and Respiratory Tracts of Children, which I published in January and February, 1913, in the *American Journal of Surgery,* I called attention to the pathology of these cases in the following words:

"Following the occlusion of a bronchus by a foreign body, compensatory dilation of not only the adjacent but also the distant lung parenchyma occurs to a greater or less degree with the production of vicarious emphysema. This is due not only to the yielding of the alveoli but also to the yielding of the bronchioles and smaller bronchi.

"If the obstruction is incomplete, during inspiration the air passes through the narrowed part and distends the bronchi and fills the air spaces, but the expulsion of air is prevented by the plugging of the tube by inflammatory products, which act as a ball valve, and thus the expiratory effort is spent in stretching the walls of the tubes."

The signs for the detection of a roentgenologically translucent body obstructing the bronchus have been well known in our laboratory for several years. I came upon them by a process of analysis similar to that which Dr. Manges used—in other words, the study of plates of chests in which the foreign body had lodged in the bronchial tree, and which did not cast any definite shadow. I do not write this with any desire to make any claim for priority. The result of such controversy is frequently that which John Kendrick Bangs indicates in an incident in the story of the Houseboat on the Styx. It may be recalled that in this story the ghosts of Shakespeare and Bacon have an animated discussion as to who wrote Hamlet. They finally agree to leave it to Sir Walter Raleigh. He, after listening to their argument, tells them they are both mistaken, for he wrote it. It would not, therefore, surprise me very much to learn that some one else saw this thing first. As Walter Pater says: "All theories of practice tend, as they arise, to their best, as understood by their worthiest representatives, to identification with each other. For, after all, the variety of men's possible reflection on their experience as of that experience itself, is not really so great as it seems."

I. Seth Hirsch
11 E. 68th St., New York.

Philadelphia, July 21, 1920.

Dr. H. M. Imboden, *Editor,*
American Journal of Roentgenology,

Dear Doctor Imboden:

Thank you for the privilege of seeing Dr. Hirsch's letter. Since reading your letter I have read the article to which he refers in his letter as published in the *American Journal of Surgery,* in 1913. This article is very comprehensive and well written. The paragraphs that he has quoted in his letter appear in his paper under the heading of "Pathology." I am unable to find, however, that in any portion of his article he makes any claim to have found any roentgenographic signs of obstructive emphysema as differentiated from compensatory emphysema.

Very sincerely yours,
W. F. Manges.

TRANSLATIONS & ABSTRACTS

CARRERA, DR. JOSE LUIS. A Pathologic Study of the Lungs in One Hundred and Fifty-Two Cases of Syphilis. (*Am. J. Syphilis,* Vol. IV, No. 1, January, 1920.)

Pulmonary syphilis still remains to-day a doubtful and little explored field for the medical practitioner. Nevertheless, clinical diagnoses of syphilis of the lungs are much more frequently made than they are given pathologic confirmation at the autopsy table. In view of the apparently increasing interest among clinicians as to the frequency of involvement of the lungs in syphilis, it is of the greatest importance to attack this problem from the standpoint of the new pathologic criteria set up by such investigators as Warthin, Fordyce, and others. This has not yet been done; and the object of this paper is to make an attempt in this direction. There is very little that is definitely known about syphilis of the lung, aside from the relatively infrequent cases of pulmonary gumma. One hundred and fifty-two cases were selected from the autopsy material of the pathological laboratory of the University of Michigan, in which an undoubted diagnosis of syphilis had been made from the presence of specific syphilitic lesions in other organs and tissues. These cases included (about one-third) those that had been clinically diagnosed as syphilitics before death, including paretics, tabetics, aortic aneurysms, syphilitic myocarditis, aortitis, hepatic syphilis, gummas of brain, lungs, liver, bones, skin and testes, salvarsan poisoning (5 cases), and other clinical forms of syphilis. The remaining cases were those in which a clinical diagnosis of syphilis had not been entertained in connection with the patient's terminal affection. In these the diagnosis of syphilis rests upon anatomic signs of syphilis alone, or upon a combination of anatomic lesions and the demonstration of the spirochete. As the result of this study he found in 12 cases out of the 152 histologic changes in the lungs that he regards as undoubted syphilitic lesions, as follows:

1. Gumma of the lung	3 cases
2. Syphilitic Paribronchitis with arteritis...	2 cases
3. Syphilitic Fibrosis with Arteritis	4 cases
4. Syphilitic Arteritis	3 cases
Total	12

approximately 8 per cent.

These diagnoses were made upon the modern histologic criteria for syphilitic lesions as given in the Harvey Lectures for 1915 and 1918 by Fordyce and Warthin respectively.

Gumma of the Lung. There were pleural adhesions, some fluid in the cavity, and a number of pigmented nodules under the pleura. Both miliary noncaseating and larger caseous gummas were found throughout the lungs. Microscopically, the caseous gummas showed three distinct zones, a central caseous area, and intermediate fibrous zone with many new blood vessels, and an outer vascular, infiltrated zone rich in plasma cells and lymphocytes. In some of the gummas the outer zone was very broad and diffuse, disappearing gradually in the thickened walls of the bordering alveoli, while others had a more discrete border, but never as sharply circumscribed as the edge of a tubercle. The lung tissue at the periphery of the gumma was compressed and pushed away, but did not show any special characteristics. Rarely did the gummas touch each other and form a continuous mass; they did become confluent as do miliary tubercles. The tissues surrounding the smaller gummas often showed a heavy deposit of anthracite pigment. The central caseous zone presented the appearance of a coarsely granular caseation in which a few nuclei in varying stages of karyorrhexis were seen. The outlines of capillaries containing blood cells and fibrin could still be made out. There was no fibrin presented in the caseous area except in these vessels, in contrast to the fibrin threads so abundantly found in the caseous centers of tubercles. The intermediate fibrous zone was made up either of young fibrous tissue or an older, more hyaline form, but never distinctly epithelioid, as in the tubercle. Fibroblasts appeared, and great numbers of angioblasts in the form of cords or young capillaries containing blood cells. This zone usually showed many plasma cells and lymphocytes, and these increased in number in the outer infiltrated zone, which may appear to be made up almost entirely of plasma cells, but capillary proliferation and increase of stroma can always be made out in this zone. The larger blood vessels in part showed the picture of syphilitic endarteritis, particularly when the vessels appeared to be the starting place of

the gummatous process. Other vessels showed hyaline change. Many very small infiltrations of lymphocytes and plasma cells, with occasional endothelioid cells occurred. These may be very young miliary gummas or simple syphilitic lesions. In some cases it is very difficult to differentiate these, when taken alone, from hyperplastic rudimentary lymph nodes or young tubercles. In some cases it may be impossible to do this, as other writers have affirmed, and the diagnosis rests upon the more completely developed lesion. The gumma, even in the youngest form, is essentially a vascular lesion, built up largely of angioblastic proliferations infiltrated with plasma cells and histogenetic lymphocytes. As the new formed vascular tissue develops, its vessels in part become obliterated or thrombosed, the connective tissue more hyaline, the cellular infiltration less, and at last the older central part caseates. Typical changes appear in the medium and larger vessels of the part, proliferation of the external and internal coats, degenerative changes in the intima and middle coats, with plasma cell infiltration. In general the elastic tissue is better preserved than in tuberculosis.

Syphilitic Fibrosis of the Lung. A very marked fibrosis was found in 18 cases out of the 152; a well marked condition of brown induration was found in 43 cases; while an increase of connective tissue associated with chronic passive congestion was present in 124 cases, or 82 per cent. These findings are very striking, and are in general accord with the changes produced by syphilis in other organs (fibroid, heart, arterial sclerosis, chronic interstitial pancreatitis, chronic fibroid orchitis, etc.). The question, of course, is to what extent this fibrosis is the result of the direct localization and action of the spirochetes in the lung tissues, or how much of it is purely secondary to the damaged heart and the enfeebled action. Are these lungs showing an increase of connective tissue the seat of a syphilitic inflammation, or is the fibrosis the result of a chronic passive congestion? Are these lungs purely cardiac lungs? The connective tissue formation in the lungs of 60 cases of tuberculosis was studied in comparison with the syphilitic lungs. This study convinces me that it is never impossible to distinguish the fibrosis of tuberculosis from that of syphilis, no matter how difficult the case may be. The earliest lesions of pulmonary spyhilis may escape our notice more easily than the early tubercle; and there can be but little doubt that many syphilitic lesions of the lung do escape our notice pathologically. The formed gumma and the developed tubercle can be readily distinguished by the vascular, closely packed, epithelioid, sharply circumscribed, conglomerating character of the latter, while the gumma appears as a more loosely arranged, less sharply delimited, vascular granulation tissue, scant in epithelioid and giant cells, and infiltrated with lymphocytes and plasma cells. The scar of the tubercle is round, sharply delimited, with concentric fibers, hyaline, scant in neuclei, devoid of vessels and elastic tissue, less given to anthracotic pigmentation, but more frequently calcified, and very often confluent or conglomerated. The scar of syphilis is irregularly radiating or stellate, not sharply delimited, more like ordinary cicatricial tissue, still contains blood vessels, often with angiectatic capillaries, continuous with the thickened walls of the nearest alveoli, still shows elastic fibers, and the outlines of old vessels and alveolar walls; the scars of gummas are extremely rarely conglomerated or confluent; the syphilitic fibrosis begins under the pleura and around the bronchi, and is more frequently anthracosed, and very rarely calcified. But the most conclusive differential point is the finding in the fibrosis of syphilis of collections of plasma cells; and such active areas are probably as frequent in syphilitic fibroses of the lung as they are syphilitic processes elsewhere in the body. Likewise, the syphilitic lesions of the vessels, when found, are so typical that they alone will fix the diagnosis. He states that he does not agree with many of the text book pictures of syphilitic arteritis in the lungs, as the conditions pictured may exist in the absence of syphilis. The general appearances of the fibrosis of brown induration and of syphilis are very much alike; the existence of the anthracotic border is common to both. The essential differences rest in the typical vascularization and infiltrations of syphilis. In the connective tissue of syphilitic fibrosis the small diffuse or focal collections of lymphocytes and plasma cells, with or without typical gumma formation, and associated with characteristic vascular changes make possible the differential diagnosis. While chronic adhesive pleuritis, old pleural adhesions and thickenings were common findings in these cases, no

characteristic changes of syphilis were found in the pleura. In one case associated with marked syphilitic lesions of the brain, aorta, heart and testes, the peribronchial tissues showed a beautiful plasma cell infiltration, with new-formed vessels, formation of a vascular connective tissue around the infiltration, with heavy deposits of anthracosis. In many places the infiltrations are nodular (miliary gummas). The bronchial epithelium is well preserved. The alveolar walls showed nothing characteristic. No changes were found in the bronchial mucous glands. In one case, associated with marked syphilitic mesarteritis of the large pulmonary arteries with aneurysm of a main branch in the upper left lobe, the peribronchial lymph nodes showed marked typical syphilitic vascular formations and thickenings, with plasma cell collections. Spirochetes were found in the artery, the aneurysm and the peribronchial infiltrations in this case.

Summary. The study of the lungs of these 152 cases gives up 12 cases diagnosed positively as syphilis upon the criteria described above. The cases fall into two groups: 1. Gumma, with peribronchial lesions and arteritis, five cases falling into this group, three of them in the first subdivision; 2. Fibrosis and arteritis, embracing seven cases, three showing definite syphilitic processes in the vessels alone. If we compare these finds of active syphilitic lesions in the lungs with those found in the other organs of the same cases we are struck by the great disproportion. The heart and aorta of every case showed typical active infiltrations, the testes of every male showed the same, the great majority showed active lesions in pancreas, adrenals and liver, and those cases in which the central nervous system was examined showed a high incidence of syphilitic lesions. Upon what grounds does the apparent greater freedom of the lungs from such lesions rest? Is the lung actually more immune to syphilis and less frequently involved in the mild inflammatory processes that are always found in other viscera? I do not think so; it is very probable that many other lungs were syphilitic, but the specific active changes were not found; and it is only upon these that we can make a positive diagnosis of syphilis. The examination made is, of course, very incomplete; only a limited amount of lung tissue was routinely preserved from the autopsies, and it was possible to examine only a small part of this tissue. The portions examined represent a very small area of the lungs as a whole; and the chances of missing such changes as are produced by syphilis are infinitely greater than of finding them. Further studies of this kind, much more intensive as to the amount of lung tissue examined, are needed before we can pass judgment upon the importance and frequency of syphilitic lesions in the lung. It seems most probable that the lungs are involved in the mild general infection of syphilis to about the same degree that the other organs and tissues are. The gumma may be infrequent, as it is in all organs, or even rarer, or it may be infrequently diagnosed, both in life and at the autopsy. What this research does show are the facts that the essential lesions of syphilis in the lungs are the same as elsewhere; and, what is extremely important to the clinician, that the lungs of the syphilitic are not normal organs. Our 152 cases of syphilis show the following conditions:

1. Chronic passive congestion (well marked)	124 cases
2. Marked brown Induration	43 cases
3. Marked Fibrosis without brown induration	18 cases
4. Hemorrhagic Infarctions	28 cases
5. Pulmonary Thrombosis	14 cases
6. Edema of the Lungs	35 cases
7. Atelectasis (Subpleural)	16 cases
8. Bronchopneumonia	45 cases
9. Tubercles (Of Clinical Importance)	21 cases
10. Excessive Anthracosis	61 cases
11. Emphysema	42 cases
12. Chronic Pleuritis	19 cases
13. Bronchiectasis	6 cases
14. Presence of Corpora Amylacea	6 cases
15. Pulmonary Gangrene	6 cases
16. Fibrosis of Peribronchial Nodes	2 cases

A terminal bronchopneumonia or croupous pneumonia occurred in a very high per cent of the cases in connection with an inadequate heart. It is, of course, impossible to state how much of the pulmonary pathology so strikingly shown in this series of cases is due primarily to syphilis of the lung tissue, or secondarily to the effects of syphilis upon the myocardium. A vicious circle will sooner or later be added a chronic passive congestion due to the myocardial lesions. To what extent does this modify the syphilitic process? We cannot say now. At any rate the great majority of autopsy cases of syphilis show lungs having a greater or less degree of fibrosis, as do the other organs and tissues, and with this fibrosis they present a varied pathologic picture.

Conclusion. The diagnosis of pulmonary

syphilis must be made microscopically. The lungs of syphilitics show an incidence of fibrosis comparable with that observed in other organs of the same cases. They show also a high percentage of pulmonary pathologic conditions, in part, at least, referable to the coincident myocardial affection. A certain number of cases (here 12 out of 152) present a specific syphilitic pathology of clinical importance, in the form of gumma, fibrosis, peribronchitis and arteritis. To what extent the high incidence of fibrosis of the lungs is due to syphilis alone can not be decided now, but it is probable that the lung is not exempt from involvement in the mild inflammatory process caused by syphilis in other organs, and which lead eventually to fibrosis.

W. W. BELDEN.

FIRMIN-CUTHBERT. Case of Appendix Containing 36 Shot; Followed by Signs of Malignant Endocarditis. (*Proc. Roy. Soc. Med.* Vol. XIII, No. 5, March, 1920.)

Man, aged forty-one. History of sudden right iliac pain fifteen months since. Present condition: abdomen distended; temperature 101° F., pulse 88. Laparotomy revealed appendix seven inches long, containing thirty-six shot. No other abdominal pathology. Blood culture showed pressure of streptococcus longus. Operation was followed by chills, confused idea, left hemiplegia and convulsions. Death occurred on the fourth day. No autopsy. Roentgenologic study in this case would have been very illuminating.

L. S. GOIN.

JANEWAY, HENRY H., M.D. The Treatment of Malignant Tumors of the Thymus Gland by Radium. (*Ann. Surg.* Vol. LXXI, No. 4, April, 1920.)

During the past year a number of patients with primary new growths of the mediastinum have been referred to the Memorial Hospital for treatment with radium. In the case of one of these patients it has been possible to settle the diagnosis exactly by examination of a portion of the tumor removed for microscopical section. Three other patients came to autopsy and an opportunity was thus afforded to study satisfactorily not only the histology of their tumors, but the relations of the primary growth and its extensions through the body. In each of these four cases the diagnosis of a primary malignant new growth of the thymus gland was established by Dr. James Ewing, who made the pathological examination and has reported one of them, and two others not observed by the writer, in a recent article in which he called attention to this group of tumors, thoroughly discussed their histology, and collected and reviewed the literature. In two other advanced cases observed by the writer the diagnosis was made from the close resemblance of their clinical course and objective findings to the cases coming to autopsy and proved by microscopical section. Finally, three additional cases which ran a more benign course and came to us at an earlier stage of the disease are herein reported. In these cases, also, the diagnosis rests on the clinical data. The significance of these last three cases, however, is great, for two of them have remained well for long periods since their treatment by radium, one of them for a year and a half, and another for almost a year; the third has only recently been treated. These results indicate that we have in radium an agent by which we may hope to produce a cure of certain malignant new growths of the thymus gland; and inasmuch as our experience indicates that malignant new growths of the thymus gland are more frequent than has generally been supposed, one should constantly bear in mind the possibility of their presence when studying patients with early thoracic affections. The probability of obtaining a favorable result in the treatment of these tumors depends not only upon the early diagnosis and application of treatment, but quite as much upon the variety of the tumor with which we haev to deal. Ewing states that "pathologically these tumors fall into two main groups: 1. Lymphosarcoma—composed of a diffuse growth of round polyhedral and giant cells. 2. Carcinoma—in which the main tumor cell is a pavement, cubical, or, rarely, cylindrical epithelium. 3. Very rarely, spindle-cell or myxosarcoma — believed to arise from the stroma of the gland—may be encountered. Of these varieties the lymphosarcomas are by far the most frequent. They vary all the way from a process akin in structure to a granuloma with a more limited and slower growth, to a very malignant rapidly growing tumor composed of a diffuse growth of small round cells in which reticulum cells are largely missing.

"Thymic carcinoma, a much rarer tumor, preserves more perfectly in its cells the epithelial structure. These tumors tend to remain local, though they may produce metastases. As a rule, they exhibit far less tendency to erode surrounding organs than is usual with carcinoma." The favorable results obtained in the cases of our series which are still well for a year to a year and a half depend, no doubt, upon the fact that these tumors belonged to the less malignant type of lymphosarcoma. The result to date in the case still under treatment, though definite, is less marked than was the state of affairs for the same length of time in the other two cases coming for treatment while their tumors were still small. This third early case probably represents a different type of disease histologically. It may belong to the carcinomas. Nevertheless, the results in these three cases, as well as the profound impression made upon the more malignant and rapidly-growing forms strongly urge the importance of an early diagnosis and familiarity with the clinical course of these tumors. The first symptom is usually cough without expectoration or haemaptysis. The cough may be associated at the very first, or very early in its course, with dyspnea. In the very beginning the majority of these cases are regarded as tuberculous processes in the lung. This was so in the three cases of their series which gave the favorable results under radium treatment. There will be with thymoma an absence of physical signs in the apices and dullness over the center of the upper portion of the sternum. If these cases are treated for prolonged periods as tuberculosis, they may lose—depending upon the rapidity of the growth—the opportunity of a very material benefit from treatment by radium. In other cases, the dyspnea is the pronounced symptom from the start and increases so rapidly that with a very cursory examination it is evident from the beginning that one is dealing with a tumor of the thorax. The very malignant cases of this type may run their course in three or four or even two months' time. The majority of the cases of lymphosarcoma of the thymus metastasize and form extensions into the lung and pleura, and the very malignant cases do so early in their course. Extension through the anterior wall of the chest or through the sternum is characteristic. It has occurred in three of the cases in the present series, has been commented on by other observers, and appears to be of frequent occurrence. Enlargement of the axillary lymph-nodes may occur before involvement of the cervical nodes; or enlargement of the axillary lymph-nodes may be out of all proportion to the involvement of the cervical of the cervical nodes. Such rapid extension to the axillary nodes suggests lymphosarcoma of the thymus. As the disease progresses, the dyspnea becomes extreme, the infiltration into the lungs and pleura increases, hydrothorax develops, the heart becomes displaced, and the large intrathoracic vessels and trachea and bronchi become seriously compressed, with consequent cyanosis and venous congestion of the upper chest, neck, and head. In a special group of cases the blood picture may early resemble that of lymphatic leukemia. In fact, this diagnosis was made in one case referred to us. Metastatic extension into the abdominal lymph-nodes and organs is frequent, but rarely acquires sufficient headway to cause symptoms before death occurs from pressure within the thorax. In all cases *x*-ray examination is the one aid to diagnosis which is of the utmost importance.

The location and appearance of the shadow are characteristic. It is immediately above the pericardium, higher than the usual location of that due to enlargement of the peribronchial glands. The radiograph is thus a valuable means of diagnosis. Many of these cases have hitherto been classed as mediastinal Hodgkin's disease have exhibited invasive characters which have aroused the suspicion that they were thymomas. Such errors, however, are not of great practical importance, as both Hodgkin's disease and true lymphosarcoma or the lymphatic glands are best treated by radium.

In conclusion it may be stated thus: (1) Malignant new growths, particularly lymphosarcomata of the thymus gland are of more frequent occurrence than has hitherto been believed. (2) Radium offers to patients with this disease a real relief, and in certain cases even a prospect of cure. (3) Every effort should be made to treat these cases with radium during an early stage, and in order to do this, the possibility of malignant disease of the thymus should be considered and a radiograph taken in the earliest stages of all intrathoracic affections.

THE AMERICAN JOURNAL OF ROENTGENOLOGY

Editor, H. M. Imboden, M.D., New York

VOL. VII (NEW SERIES) SEPTEMBER, 1920 No. 9

THE VALUE OF THE ROENTGEN RAY IN THE STUDY OF DIVERTICULITIS OF THE COLON*

THE RECOGNITION OF DIVERTICULITIS AS A CLINICAL ENTITY; CONSTIPATION AS AN ETIOLOGICAL FACTOR; PATHOLOGICAL CHANGES; SYMPTOMS; DIFFERENTIAL DIAGNOSIS; RADIOGRAPHIC CLASSIFICATION OF MULTIPLE DIVERTICULA; BIBLIOGRAPHY.

BY ARIAL W. GEORGE, M.D. AND RALPH D. LEONARD, A.B., M.D.

BOSTON, MASS.

THE term "multiple diverticulitis" when applied to the large intestine refers to the presence of one or more sacculations projecting from the exterior of the gut, together with their secondary inflammatory changes. As many of these pathologic sequelae involve the tissues around the intestine, "peri-diverticulitis" might be a more apt term.

Diverticulitis to-day occupies an important place in medical literature and it is recognized as a distinct clinical entity by every operating surgeon of large practice. It is only within the past twelve or fifteen years that the profession has had an intelligent appreciation of the importance of this condition, although Graser presented in 1898 a fairly accurate clinical and pathological description of "diverticulum formation" in the large bowel and showed that such cases were not uncommon.

Previous to Graser's work, however, the literature on "diverticulitis" consisted in the occasional report of isolated cases. Virchow in 1853 described certain "pathologic changes involving the descending colon and the sigmoid characterized by isolated, circumscribed, adhesive peritonitis." He even described some of the possible complications, adhesions, constrictions, perforation, etc. He did not, however, note the presence of diverticuli as the original cause, considering constipation as the etiologic factor; neither did he attempt to describe the clinical picture.

From 1900 on many important contributions were offered, particularly by American observers. Fisher in 1901 and Beer in 1904 did experimental work on the etiology of the intestinal diverticula. In 1907 the Mayos, Wilson and Giffin reported several operated cases of diverticulitis, contributing particularly to the clinical aspects of the disease. In the same year Brewer offered a paper also describing the clinical manifestations of diverticulitis entitled "Etiology of Certain Cases of Left-sided Intra-abdominal Suppuration." In the following year Ashhurst reported a case of "Sigmoid Diverticulitis" in a child. This patient is the youngest case

* This article was published IN PART in the *Medical Clinics of North America*, March, 1919. It is through the courtesy of Mr. R. W. Green of W. B. Saunders Co. that permission was given to republish the article and the cuts.

on record. McWilliams about the same time reported cases emphasizing some of the serious sequelae.

Telling in 1908 for the first time collected and analyzed the recorded cases, classifying the pathologic changes and clinical results. This classification has furnished the basis for most articles of importance written since that date. In 1911 Telling and Gruner amplified this classification, basing their conclusions on a much larger number of cases.

During the last seven or eight years there have been many contributors to both the clinical and pathologic features of "multiple diverticulitis," among whom are Mayo, Wilson, Giffin, Hartwell and Cecil, Graves, Erdmann, and particularly McGrath. His paper on the "Etiology and Pathogenesis of Colon Diverticula" is especially valuable.

The *x*-ray as a means of diagnosis of multiple diverticulitis was first brought to our attention by Dr. L. T. LeWald, who made a roentgen diagnosis of sigmoid diverticulitis in a case reported by Abbe in August, 1914.

Carman, in November of the same year, and Case, in the following year, described the radiographic appearance of multiple diverticulitis of the colon. Since then a few contributions on this subject have been made by roentgenologists to periodicals and textbooks. These papers, however, are in the nature of reviews and confirmation of Carman's and Case's work, and offer nothing particularly new.

In order better to understand the radiographic appearance of multiple diverticulitis, it may be wise to consider some of the pathologic aspects. The following statements and classifications represent in general a résumé of the more recent contributions to the pathology and etiology of this disease.

Diverticula may be classified in two general groups—the congenital group and the acquired group. The congenital group is small. Meckel's diverticulum in the small intestine and a few other developmental anomalies, such as a persistent urachus, compose this class. These congenital diverticula do not enter into the scope of the present paper.

As Dr. Charles Mayo states: "The various viscera and tubular structures of the body are subject to acquired diverticula. Even the large blood-vessels are prone to this condition in the form of sacculated aneurysm."

The group of acquired diverticula comprise practically all the diverticula which are of clinical importance. The esophageal diverticula, the various diverticula of the duodenum, ileum, and the multiple diverticula of the large intestine, in which we are particularly interested, belong to this group.

The acquired diverticula are further described as "true" or "false," these terms being used with reference to the structure of the walls of the diverticulum, as compared to the structure of the walls of the normal organ. Some pathologists use the terms "complete" and "incomplete" synonymously with "true" and "false."

A "complete" diverticulum presents in its walls the same tissues and the same arrangement of lining membranes as the normal intestinal wall. The "incomplete" or "false" diverticula consist of but part of the elements found in the normal intestinal wall. The diverticula of the colon probably belong to this latter group, their walls being composed of merely the mucous and serous coats. There is no "muscularis" as found in the normal intestinal wall. McGrath speaks of these diverticula as "hernia mucosae."

It has been suggested that originally they were "true" diverticula, the muscle coat simply atrophying from disuse. In view of the probable etiology of diverticula we feel that the idea of "muscle atrophy" is unlikely.

Diverticula of the large bowel may be found in any division of the large intestine, but are most commonly found in the descending colon and sigmoid. McGrath's figures in a series of 32 cases are typical. In 27 cases diverticula were found in the descending colon and sigmoid, 2 cases in the rectum, one case in the transverse and hepatic flexure, and one in the anal ring.

Our observations as radiologists would lead us to believe that diverticula occur in the ascending and transverse colons more frequently than has generally been believed.

The diverticula in this location, however, are less likely to give symptoms than in the descending colon and sigmoid, hence do not come to the attention of the surgeon or pathologist.

The number of diverticula present may vary from 1 to 100 or more. Hauseman found 400 at autopsy in a man of eighty-five dying from pneumonia. It is generally agreed that colon diverticula are multiple and that 10 to 20 are the average number found.

They vary in size from a small fraction to two or more inches in diameter. The tendency is gradually to increase in size, the earliest stages being microscopic. The average size found at autopsy or operation is about that of a pea.

They are of variable shape, being usually round or ovoid. Some are distinctly pedunculated, with a minute opening into the lumen of the intestine.

FIG. 1. DIVERTICULA OF SIGMOID. The pouches are, for the most part, into the appendices epiploicae. (Taken from Maxwell Telling and Gruner, *British Journal of Surgery*, Vol. iv, No. 15.

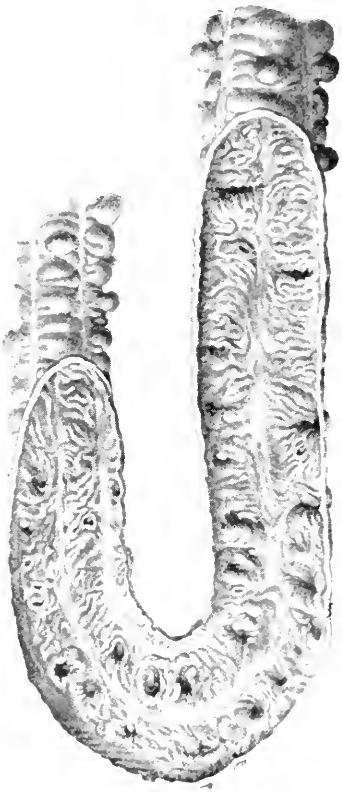


FIG. 2. PORTION OF DESCENDING COLON. Specimen laid open to show the internal orifices of the diverticula. (Taken from Maxwell Telling and Gruner, *British Journal of Surgery*, Vol. iv, No. 15.

The contents of these pockets are almost entirely fecal material, the consistency of which is variable. Occasionally the fecal material becomes so inspissated as to produce fecaliths. McGrath speaks of "concretions becoming incapsulated within the diverticula and, the pedicles sloughing, give rise to free bodies in the abdominal cavity." Numerous writers have reported foreign bodies in the diverticula.

The diverticula project from the exterior of the gut, usually close to the mesenteric attachment (Figs. 1 and 2). They may be found between the two layers of peritoneum forming the mesentery. It is also observed that the diverticula are in close proximity to the epiploic appendices.

Under the microscope the walls of the diverticula are seen to consist of mucosa, usu-

FIG. 3. NORMAL COLON. Plate made following a barium enema.

...OLON. Plate made twenty-four hours ...ter a barium meal.

ally submucosa and serosa. There is complete absence of smooth muscle-fiber. In some of the larger diverticula the lining of epithelium is more or less obliterated, due to the continued pressure of the fecal contents.

There is no obvious reason for believing that the formation of a simple colon diverticulum will necessarily be the source of symptoms. In fact, we frequently find evidence of diverticula on the *x*-ray plate without the patient presenting any local symptom. It is apparent that only when pathologic changes take place that are secondary to the diverticula do the patients complain. It is difficult to estimate what percentage of diverticula have inflammatory changes such as to produce symptoms. Telling estimates that 60 per cent of all persons having colon diverticula may have symptoms.

It is clear, therefore, that the recognition of inflammatory sequelae is of utmost importance in the consideration of multiple diverticulitis. In general, the various secondary changes and complications are the result of infection through the walls of the diverticula. They have been classified for convenience in various ways. The following is as typical as any:

(*a*) *General peritonitis* may be produced by the actual passage into the peritoneal cavity of bacteria or their toxins through the thinned-out walls of the diverticula, some of the walls being so thin as to consist only of peritoneum.

(*b*) Acute gangrenous inflammation may result from strangulation at the neck of the pedunculated type of diverticulum.

(*c*) The chronic proliferative extramucosal inflammation is the most constant pathologic process. Telling considers this condition the most important. These proliferative changes produce in time large palpable masses. These masses tend to surround the gut. Embedded in them are the diverticula. Later they tend to actual intestinal obstruction. It is this type of in-

flammation to which the term "peridiverticulitis" applies, and it is this complication which is frequently diagnosed as cancer or sarcoma.

(*d*) It is evident that, with a mass of connective tissue in close proximity to other organs, adhesions involving these organs will arise. The bladder, small intestine, and pelvic organs are the viscera most commonly affected.

(*e*) Perforation is one of the most serious complications. This may be *acute*, perforation taking place through the thinned-out diverticulum wall or possibly through an ulcerated area. This type of perforation may follow severe strain. Chronic perforation may slowly take place into the peridiverticular mass of connective tissue. This may be associated with abscess formation. Fistulae connecting the colon with the bladder or small intestine may follow a chronic perforation.

(*f*) Chronic inflammation of the mesentery as a complication of diverticulitis has been reported by several, among them Telling and McGrath. The late changes in mesenteritis are of importance, in that contracting bands of connective tissue in the mesentery may be an etiologic factor in the production of some cases of volvulus.

(*g*) The development of *cancer* on the inflammatory mass is a possibility. The condition is analagous to the development of cancer on a chronic indurated gastric ulcer. McGrath reports that in his series of advanced peridiverticulitis with formation of a mass of connective tissue, 25.9 per cent showed evidence of malignancy.

Beer, Wilson, Telling, Giffin, McGrath, Hartwell, and Cecil have all presented theories as to the cause of diverticula. The following factors are worth consideration:

1. Age: Most cases occur in people beyond middle life. Occasional cases

Fig. 5. Normal Colon. Plate made after a barium meal. Some hypertonicity. Note appearance of haustra in transverse colon, likely to be confused with diverticula.

Fig. 6. Normal Colon. Following a barium enema. Note the atonic condition of the intestinal walls.

FIG. 7. MULTIPLE DIVERTICULA. Plate made twenty-four hours after meal. Diffuse distribution of the diverticula over transverse colon, descending colon and sigmoid. Simple diverticulum formation without inflammatory changes. Class I.

are reported in patients under thirty. Ashhurst reports a possible case of seven years.

2. Males are twice as susceptible to diverticula as females.

3. Obesity seems to be a definite predisposing cause; on the other hand, rapid loss of weight may be followed by diverticulitis.

4. The normal muscle structure of the colon, particularly the arrangement of the muscle-fibers, is thought to predispose toward diverticulum formation.

5. The physiologic rôle of the sigmoid, in that it contains gas and fecal material under more or less pressure, may be an etiologic factor.

6. The points of entry for blood-vessels passing through the intestinal wall seem common sites for diverticula. These points of entry are also close to the appendices epiploicae.

7. Another predisposing factor may be a variation in the size of the blood-vessels as found in congestion from venous obstruction, or high arterial pressure in cardiorenals or advanced arteriosclerosis.

8. There may be a congenital predisposition.

9. Simple muscle weakness in the intestinal wall may have a causal relation to the presence of diverticula.

One or all of the above factors may be involved in the production of diverticula. In general, herniae of any kind are the result of *increased pressure* within a cavity plus a *local weakness* in the wall. In the region where diverticula most commonly occur (the sigmoid) the intestine is subject to *increased pressure* from accumulating feces and gas.

Weakness in the wall may be produced by localized fatty degeneration of the muscle; degeneration from cachexia; the foramen for the blood-vessels with the coat of connective tissue are less resistant than the surrounding muscle-fiber, etc.

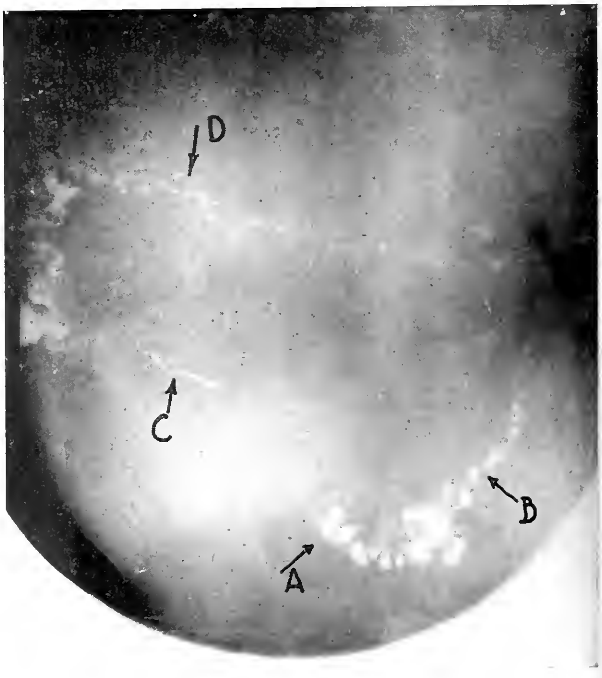


FIG. 8. MULTIPLE DIVERTICULA. Plate made twenty-four hours after barium meal. A few simple diverticula diffusely distributed at *A*, *B* and *D*. Appendix visualized at *C*. Patient has no symptoms. Class I.

Multiple diverticulitis presents a fairly definite clinical picture. The average age of the patient is from forty-five to sixty, and in general there is a marked tendency to obesity. In our cases diagnosed by the x-ray, the majority of the patients weighed about 200 pounds. Men seemed more susceptible than women.

A history of chronic constipation is found in about one-quarter of the cases. A picture of chronic obstruction with alternating diarrhea is suggestive, the chronic obstruction being from the secondary connective tissue changes.

Pain is present in a large percentage of cases. In the chronic type there is frequently a long history of attacks of crampy pain in the left lower quadrant. About 15 per cent give a story of abdominal pain of considerable severity. It must be remembered that symptoms are the result of the secondary pathologic changes. These may vary all the way from acute peritonitis to acute obstruction, so that the symptoms of pain may be variously manifested.

Fig. 9. Multiple Diverticula. Plate made twenty-four hours after barium meal. No symptoms; no inflammatory changes. Class I.

Fig. 10. Simple Diverticulum. Plate taken after barium enema. Class I.

The simple diverticula without secondary inflammation changes probably do not give symptoms.

A palpable tumor in the left side is found in about 30 per cent of the cases giving symptoms. It is usually an elongated "sausage-shaped" mass lying commonly just above and more or less parallel with Poupart's ligament. Frequently it is mobile. A characteristic of this tumor is its variability. It may appear and disappear several times, its appearance being accompanied by signs of inflammation.

Abscess formation, local peritonitis, obstruction, etc., all show their usual clinical signs of fever, leukocytosis, pain, etc.

Rectal examination is negative in all cases except where there is actual diverticulum formation in the rectum itself. The proctoscope reveals nothing.

Multiple diverticulitis is mainly an extra-mucosal disease of the intestine, so that commonly the mucous membrane remains intact. As a result the passage of macroscopic blood is not commonly associated with diverticulitis. This is an important point in the differentiation of cancer. Carcinoma is a mucosal disease and associated with bleeding.

Fig. 11. Multiple Diverticula. Plate made after a barium enema. Two diverticula seen. Class I.

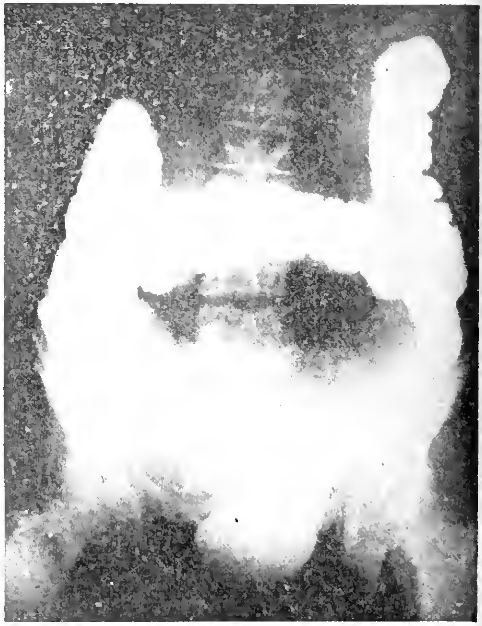


Fig. 12. Multiple Diverticula After a Barium Enema. A few small diverticula. Class I.

In the differential diagnosis carcinoma of the colon is the important condition to be ruled out. The pathologists tell us that possibly 25 per cent of the chronic indurated diverticulitis cases become malignant.

But, in general, a patient who is well nourished and continues to maintain good nutrition in spite of symptoms; who has a long pain, localizing in the left lower quadrant; who presents at times a palpable mass in the lower left quadrant; usually who has not passed macroscopic blood; who may present evidence of vesical fistulae, and with a negative sigmoidoscopic examination—such a patient may reasonably have made a diagnosis of chronic proliferative diverticulitis.

In carcinoma of the colon there is usually an early loss of flesh. Pain is not a constant symptom until obstruction sets in. Tenderness is a late finding. Blood, on the other hand, may be an early finding. When tumor is present, it is permanent.

From the other forms of pelvic inflammation it may be difficult to differentiate multiple diverticulitis. Left-sided salpingitis can usually be ruled out by the x-rays. In the presence of a palpable left-sided tumor one must always consider diverticulitis.

Up to the present time roentgenologists have perfected no special technique for viz-

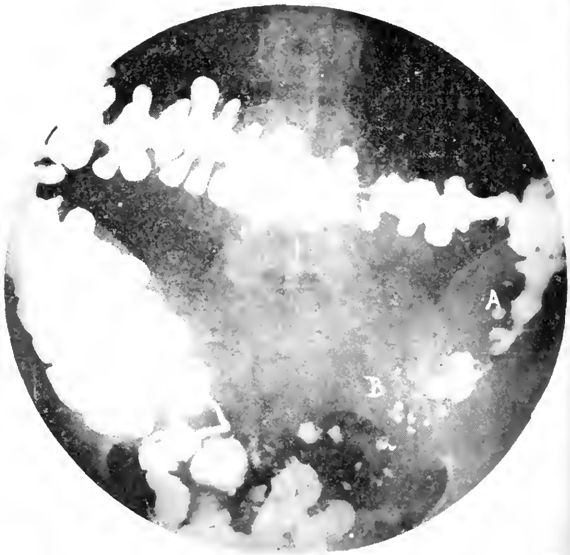
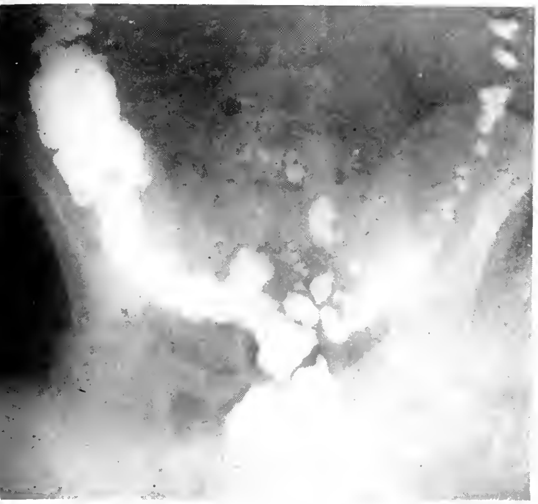


Fig. 13. Multiple Diverticula. Plate made twenty-four hours after barium meal. Note that the diverticula are definitely localized at junction of descending colon and sigmoid *A* and *B*. There is narrowing of the lumen of the colon from inflammatory tissue and spasm. Class II.



'IG. 14. MULTIPLE DIVERTICULA. Condition similar to Fig. 13. Class II.

ıalizing colon diverticula. Such cases of mul-iple diverticulitis as have come to our at-ention have been found in the course of rou-ine x-ray intestinal examination.

For those roentgenologists who do not nake a routine practice of radiographing he abdomen previous to the administra-ion of the barium meal we wish to em-phasize the importance of this preliminary tudy. Just as preliminary routine plates of the right upper quadrant will usually visualize a gall-stone, so plates of the left ower quadrant oftentimes will give evi-lence of importance in the question of nultiple diverticulitis.

From the pathology we learn that fecal-ths may be found in the diverticula due to he prolonged retention of fecal material. On account of the deposition of calcium he fecaliths are capable of casting distinct hadows on the x-ray plate. Unless pre-iminary plates are made such shadows vill be obscured by the barium meal.

Diverticula which have become sepa-ated from the intestine and are free odies in the abdominal cavity may pro-uce a shadow on the plate. Their free novement will be demonstrated.

These preliminary plates may also reveal hadows which later in the examination night lead to confusion unless their pres-ence had been previously recognized. Calculi in the left kidney or ureter; calcified glands, retroperitoneal or mesenteric; phleboliths; sclerosis of iliac arteries—all may produce shadows somewhat simulating the contents of diverticula.

The plates should be made both on the front and back. In our experience an intensi-fying screen allows us to use a little less penetrating ray, resulting in a more con-trasty plate. This additional contrast, slight as it may be, frequently makes all the differ-ence between showing and missing an ob-scure shadow. The fluoroscope helps in dif-ferentiating a movable and fixed shadow, and particularly in determining if it moves with respiration.

After the preliminary examination the patient is given the opaque meal. The meal which has been used rortinely for several years in general gastrointestinal examina-

FIG. 15. MULTIPLE DIVERTICULA with beginning narrow-ing of the colon at A. Plate made following the bar-ium enema. Rather diffuse distribution of the diverti-cula throughout the descending colon and sigmoid. Class II.

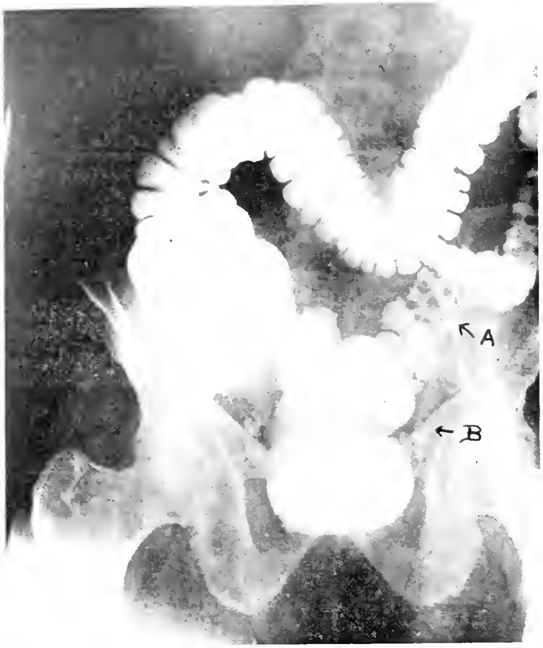


Fig. 16. Multiple Diverticula. Plate made after barium enema. Localized diverticula at *A*, with narrowing of the lumen mainly due to spasm. Phleboliths at *B* might be confused with diverticula, unless their presence had been previously recognized in the "preliminary examination."

Fig. 17. Multiple Diverticula. Plate made after the [illegible]. Isolated diverticula at *A* and *B*. Secondary inflammatory changes involving descending colon. Class II.

Fig. 18. Localized Diverticula Formation. Plate m after barium enema. Two diverticula at *A* and Narrowing of the colon at this point. Symptoms chronic obstruction. Class II.

tions has proved satisfactory for the dem- onstration of colon diverticula. It consists of two glasses of buttermilk and 1½ ounces of barium sulphate in each glass. This is taken on an empty stomach. With the buttermilk meal the appendix is more readily filled than with other meals, so it is likely that diverticula are more readily filled with this type of meal.

Twenty-four hours after the meal we find the best filling of the colon. It is on this plate that the diverticula are first visualized. As a frequent site for the diverticula is near the mesenteric attachment, it is obvious that in a simple antero-posterior plate these shadows may be hidden by the mass of barium filling the lumen of the colon. Palpation under the fluoroscopic screen or stereoscopic plate may bring to light some of these hidden diverticula (Figs. 3-6).

As these pockets tend to retain the barium over a prolonged period, we have found that plates made thirty-six to forty-eight hours after the meal show the diverticula to the best advantage. At this time the lumen of the colon will be entirely free of the barium meal, and the barium-filled diverticula stand out clear and distinct.

[FI]G. 19. DIVERTICULA AT *A* AND *B*, with narrowing of the colon at *B*. Barium enema. Class II.

It is of importance to determine the length of time barium is retained in these pockets. This, of course, is variable and depends upon the type of diverticulum. We have observed cases where plates made not only days but weeks after the meal still showed evidence of barium in the diverticulum.

The examination with the barium meal should always be followed up with the barium enema. The enema is not so satisfactory as the meal for visualizing the actual diverticula. The pockets do not fill readily, perhaps for the same reason that the appendix is not filled by the enema. Again, the colon is usually so distended by the enema that the mass of barium very easily obscures many of the diverticula. The enema is of value, however, in bringing out some of the secondary pathologic changes, such as chronic thickening of the intestinal wall, with narrowing or beginning obstruction; abscess cavities, chronic perforation, fistulae, etc.

Our practice is to mix up 5 or 6 ounces of barium with a pint of buttermilk and water enough to make a quart. This is given slowly with very little pressure; the elevation of the container is usually not more than two feet above the table. A soft rubber rectal tube is used, the end being inserted just beyond the internal sphincter. The patient, if possible, lies on the left side.

This solution is not irritating, and the patient usually retains it comfortably for 10 minutes or more. Plates and study with the fluoroscope are made immediately. In fact, it occasionally gives valuable information to watch the abdomen with the fluoroscope as the enema is being given.

The patient is next asked to empty the colon as completely as possible, and further plates are made. These last plates will visualize any diverticula which retain the barium, and also give us information as to the ability of the patient to empty the colon.

(To be concluded in the October issue.)

ELECTRICAL DANGERS IN X-RAY LABORATORIES

By J. S. SHEARER, B.S., Ph.D.

ITHACA, NEW YORK

THE recent death of Dr. Jaugeas by electrocution in an *x*-ray laboratory in Paris has served to direct attention to the danger in the operation of *x*-ray devices where proper precautions are neglected, or where the idea of safety is based on misconception of the fundamental facts involved. In the July, 1917, number of this JOURNAL the writer described briefly the sources of danger and pointed out some remedies. It is interesting to note the following review of this article in the *Journal de Radiologie et d'Electrologie:*

"The author describes what might happen if the patient were subjected to an accidental spark. Without denying the extreme unpleasantness that would result from a short circuit between the patient and one of the high tension wires we may remind the author that confiding the operations in radiology only to a technician of experience, and continuous oversight of the patient and the apparatus, are, in practice, infinitely more efficacious than the automatic methods he prescribes. *Moreover one has never yet recorded, to our knowledge, a fatality due to contact with a high tension circuit used in radiology.*"

The death of Dr. Jaugeas and of several others less widely known, and the serious injury to patients in numerous instances, is sufficient answer to the ideas advanced in this review, especially as Dr. Jaugeas had had many years' experience. As a matter of fact very few roentgenologists have acquired reliable information on this important subject. On this account, and because of the rapid introduction of low power apparatus, it has seemed advisable to extend the remarks of the previous article even at the risk of some repetition.

While it is true that serious accidents in the operation of modern *x*-ray apparatus have not been numerous, yet the relatively small number of injuries is a matter of good fortune, as opportunities for contact with dangerous conductors have been extremely general.

There is evidently much misunderstanding as to what is or is not dangerous in this connection, resulting in advice often misleading, and, if followed, more likely to increase danger than otherwise. The result of an electric shock will depend in part on the condition of the subject, in part on the current and its duration, and also on the path followed by the current between the areas where current enters and leaves the body. Death is usually regarded as due to action on the heart and respiration, consequently the condition of the heart will be a large factor in the matter. Not only may death be due to an actual lesion, but a fatal result may follow from fright. On this account one is hardly justified in placing a lower limit on the voltage to be regarded as dangerous. Cases are on record where death has been caused by contacts with an alternating power circuit of less than 100 volts. Such cases may be difficult to explain, just as in the case of survival after contact with very high voltages that have not given a fatal result. Yet no one cares to assume that a given individual would not be killed or injured by such shock.

Keeping in mind the possibility of death from comparatively low tension circuits, it is clear that the operation of *any* *x*-ray tube at the voltage and power needed for fluoroscopic, radiographic or therapeutic work requires an outfit *potentially* dangerous. The only exception would be where the *entire* outfit is surrounded by a grounded metal shield or by a complete insulator. For some work such equipment may eventually be realized, but the present appliances must be used for a long time at least.

Leaving out of account the relatively rare cases where ordinary voltages give a fatal shock, it is generally agreed that a current of 100 ma. *maintained* through the vital organs for a few seconds or less is practically sure to be fatal. There have, no doubt, been numerous instances where a current greater than this has not resulted in death, but at any rate one would not care to risk it.

The current through the body will depend on:

1. The resistance of the body, including the contact resistance where current enters and leaves the skin.

2. The voltage at each instant tending to force current from the point of entry to the point or region where it leaves.

The total resistance of the body may be as low as 5,000 ohms depending largely on the area of contact, on the dryness of the skin and on the individual. Thus to originate and maintain a current of 100 ma. we must have 500 or more volts between the points of entry and emergence. Note that any voltage is more dangerous if maintained for more than a brief instant. Although a static machine will give many kilovolts on open circuit it can not maintain voltage when a few milliamperes are drawn and there would be little chance of serious result to a person in good health from contact with its terminals. Most induction coils in the early days were so designed as to give long spark gap on open circuit, but there was very little maintained voltage on an external resistance as low as that of the human body; thus they were not specially dangerous.

A Leyden jar or other condenser charged to several thousand volts may be discharged through the body causing an unpleasant shock but with little danger, as the voltage not being sustained by a generator there is only a brief rush of current rapidly falling to zero.

It should be noted that a high voltage applied to one point of the body when insulated from all other contacts, thus charging the body to a high potential, is not necessarily dangerous. One can stand on an insulated stool and receive a current charging the body to many thousand volts without danger. But the *maintained* flow of charge through the body is quite a different matter.

In order to understand the reasons for not doing certain things that increase danger, it may be well to consider the fundamental features of an electric circuit.

First, one should note that all electric charge comes from matter being separated from atoms by certain agencies known as generators. The amount thus separated is a very small fraction of the total charge bound up with the atoms of even a limited amount of material. Thus if all existing generators were set to pumping charge of one sign, say from the earth to some other body, the effect on the electrical condition of the earth would be negligible, much as though all the existing pumps were set to pump out the ocean—the resulting change in sea level would not be noticeable even if no water *ran back*. We therefore consider the earth as in a stationary electric condition. This is expressed by saying that earth *potential* is always zero, exactly as we use sea-level as a starting point for measuring levels. When an electric charge tends to move to or from the earth the body on which this charge is located is said to be at a *potential* of a certain number of volts. If a point on any conducting system is joined by a conducting path to the earth that point is said to be brought to *zero potential,* or is grounded.

The function of a generator, battery, dynamo, or transformer is to create differences of potential by the separation and movement of charge, thereby causing and maintaining electric current when conditions permit transfer of charge by any outside conducting path.

To illustrate, consider first the *primary* circuit of the usual x-ray transformer. The generator (Fig. 1) causes a voltage or potential difference of 220 volts between its terminals; a portion of this may be used in the control resistance, the rest is consumed in the primary. This *distribution* is quite independent of the potential of any part of

this system as referred to the earth. In fact the entire system may be insulated from earth and given a static charge to thousands of volts and operate just as before.

If now we join any single point to earth, as at Q, that *point* acquires earth or zero potential. Assuming a good conductor between Q and A, the latter point will likewise be at zero potential and P will differ from Q by 140 volts, while B will be 220 volts

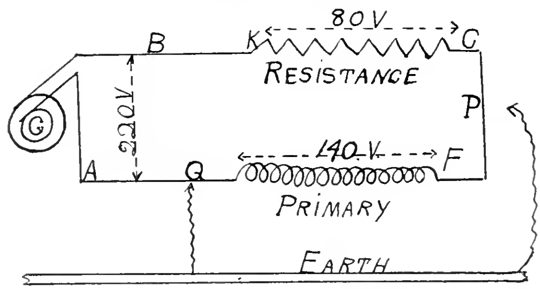


FIG. 1. EFFECT OF "GROUNDING" ONE SIDE OF THE PRIMARY CIRCUIT OPERATING AN X-RAY TRANSFORMER THROUGH RESISTANCE.
Potential difference between earth and line G to K, 220 V.
Potential drop in resistance 80 volts.
Potential difference between lines C, F and earth, 140 V.
Fall in potential through primary, 140 volts. Grounding another point, as P, may seriously disturb electrical conditions, depending on the resistance of path PEQ.

above or below zero. Grounding a second point, say at P between F and C, will tend to divert current from the primary to the earth, thence to Q. The amount of current so diverted will depend on the resistance over the path PEQ as compared to that of the primary. Contact between K and B would cause more current through the body than contact at P.

Now if there is no *ground* on the circuit one would get no shock by contact with either Q or P. But if one point, as Q, is "grounded" and one point of the body is "grounded," contact at P will allow current to flow through the body to earth and thence to Q.

The reader should note that these "grounds" may or may not allow any considerable current to pass depending on the resistance of the path PEQ and on the voltage between these points. In the case shown but little current could pass through a human body, as the resistance would be too great for the potential available. Observe that two contacts are needed; both may be direct to the circuit, or one may be indirectly made through the earth. So that a "ground" may make it easier to get a shock.

When we deal with much higher voltages the principles remain the same, but it becomes possible to force currents over much greater resistances and one does not need so low a resistance between the active line and the earth to have an effectual "ground."

Fig. 2 shows the electrical features of a transformer circuit where the middle of the secondary is connected to the case or is, for high potential purposes, "grounded" even though no conducting wire runs to "earth." Assuming operation at 60 K. V., i.e., at a little more than a 5 inch gap, the center of the

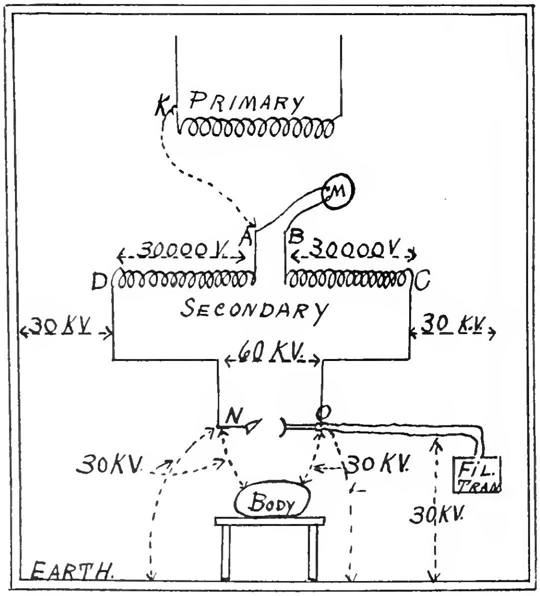


FIG. 2. ELECTRICAL SYSTEM 60 K.V. OPERATION. A AND B MAY BE CONNECTED TO A MILLIAMMETER, OR JUST CONNECTED TOGETHER BY A WIRE. A and B may be regarded for our purpose as having zero or earth potential. If the table is a conductor and is grounded, the patient's body becomes of earth potential. If body is insulated for several thousand volts, the nearest region of earth potential will not be the patient's body. *Note that when the body is between a conductor and the tube or line, danger is increased by grounding either the body or the conductor.*

secondary will be substantially at earth potential, each terminal will differ in potential from earth by 30 K.V. Thus if a pointed conductor connected to earth were brought about 2½ inches from either terminal there would result a discharge to earth. Current passing from C through earth back to B. While one would be quite safe in touching the point B, or a milliammeter connected as shown, there would be grave danger in a simple direct contact with a terminal or even in approaching close enough for a spark from either terminal or the line, although only *half* of the available voltage is involved. The advantage of this construction is that there is never more than *one half* the working tube voltage tending to cause discharge to the earth or anything connected therewith.

Sometimes in outfits designed to operate on *low* gap one terminal or line of the high tension is grounded. This makes contact by operator or patient with that terminal or line entirely safe; but there is twice as great a risk of spark-over from the other terminal as there is in the case of a grounded middle working at the same gap. One may also connect *one* point on the primary circuit to *one* on the secondary without any increase in danger. When this is done no *low resistance ground* is permissible from either primary or secondary. Serious damage to apparatus has resulted when such a second ground has been made; in fact all ground connections for apparatus protection are best made through suitable resistances.

Consider now a human body between two conductors whose potential difference exceeds a safe limit. If there is an adequate additional resistance or insulator between the body and both or one of these conductors there is no danger. Thus in moderately high tension power work, rubber gloves, insulating mats or platforms, oil switches, etc., are utilized to *insulate* the attendants. If both patient and operator were perfectly insulated from earth there would be no danger from contact with *one* side of a high tension circuit, or if sufficient insulating resistance were placed between them and *one* line they could not be injured by contact with the other side or line. Thus complete insulation of patient and operator from all parts of the high tension lines would be ideal if it could be done without interfering with the work. But no possible system that permits contact with or proximity to a high potential can be made entirely safe.

Assume now, as is usually the case, that the operator concerned is grounded. He must then ensure that no part of his body comes within sparking distance of any part of the high tension line.

In fact there should be a considerable factor of safety, so that the insulation between the body of operator or patient and any point on the high tension circuit ought not to be less than that of an air gap of twice the spark length of a discharge from the high tension line to a pointed conductor connected to the earth.

Thus when using a 9 inch gap on a transformer with a secondary grounded at the middle the shortest distance from the body to the nearest point of the circuit should not be *less* than nine inches. A much greater distance is desirable and except in deep therapy there is no reason why it should not always exceed double the sparking distance to earth.

We now need to consider the danger to the patient more in detail. Were the patient placed on a perfect insulator and *also* prevented from getting dangerously near both lines on opposite sides of the tube at the same time, he would be electrically safe. But when placed on a *grounded conducting table danger is greatly increased,* quite contrary to traditional belief. This may be seen from Fig. 2. The path of least resistance from either terminal to earth is from the terminal to the body, thence to the metal table. It makes no difference whether the tube stand is grounded as well as the table or not in so far as danger of electrocution is concerned, since the tube terminals are insulated from the stand in all cases. Also we may call attention to the fact that for high tension work

the resistance of the body may be regarded as negligible in comparison with that of a small air gap.

Hence safety of the patient when in contact with any conducting body and between this conductor and any portion of the high tension line is only insured by suitable insulation *between* the line and the patient. Grounding such a conductor, so that discharge from the line to earth would have *least resistance by passing through* the body, increases danger. The use of any metallic table for radiography or treatment where the patient is between the tube and the table should be prohibited. It should, however, be observed that when a horizontal or vertical fluoroscope is used the patient is *not between* the *high tension* and the metal and no danger to the patient arises from grounding.

Keeping in mind the above principles, one may ask: How are they to be applied, or in what particulars are present installations dangerous? One way to answer these questions would be to point out how a laboratory might be arranged so as to reduce the possibilities of danger.

First one must condemn the relegation of *x*-ray work to cellars, closets or dark and damp quarters where no one has a right to ask operators or patients to risk their lives in operating high tension apparatus. A considerable number of hospitals are open to just criticism in this respect. Also one must unqualifiedly condemn the crowding of apparatus into inadequate space. The room in which Dr. Jaugeas met his death was reported some months earlier as containing so many odds and ends of apparatus as to make it hardly possible to move about. Rooms to be used for radiography or therapy should be well lighted, dry, well ventilated and not overcrowded.

The present custom in American laboratories of using a large transformer for all work and running high tension lines from one room into another is a continuous menace, as it is always possible for one to attempt to make connections when the line is alive. The practice of having the operating switch board in a separate room at some distance from the tube stand and often having only a small window for observation is a great risk. There have been several cases of severe shock to roentgenologists or assistants when someone entered the booth or separate room and closed the switch without observing that the other party was adjusting the tube or that the patient had moved to a point of danger. There should be no possibility of closing the switch without standing facing the tube and with a clear, unobstructed view of the entire high tension system. The writer would advise a spring floor switch in series with the timer or operating switch, so that the operator must stand in one position in order to close the circuit, and in case of accident removing the foot would open the circuit irrespective of the timer. This would correspond to the "dead man's" button on electric cars.

Fluoroscopy can now be done with self-rectifying tubes and small transformers, avoiding all risk of having several connections to the same machine, as well as all expensive and complicated over-head systems. In a fluoroscopic room, since operation in darkness is essential, all high tension lines should be so protected as to preclude the possibility of any person, whether familiar with the apparatus or not, coming within ten inches of any part of the high tension circuit. The handles controlling the diaphragm should be of good insulating material and mounted so as to avoid proximity to the high tension line. A red light in shunt with the foot switch and in series with a line switch may serve two purposes: it indicates danger by showing that the main switch is closed, and also serves for weak room illumination when the foot switch is open. If both a horizontal and a vertical fluoroscope are to be operated by a single transformer, changes in connection from one to the other should be made by an oil-immersed switch of proper design. This will eliminate corona and needless exposure of the high tension circuit.

There should be no radiography or therapy using a metal table with the tube above

the table, quite irrespective of whether the stand is attached to the table or not. This means the use of a table top of insulating material with ample insulating supports between it and the metal frame or support.

The overhead high tension system should be of tubing (this may be brass instead of copper) firmly mounted in insulating supports. These tubes should extend to the transformer terminals. No part of the overhead should be less than seven feet from the floor and *only one set of reels should be attached*. No wires or other conductors should be suspended above or below the overhead system, or so that they may swing near to it. *Coolidge filament* wires are part of the high tension circuit and must be treated as such. Reels should be of substantial construction and mounted so as to preclude any possibility of their falling. Any reel permitting a sagging wire should be discarded or repaired at once. The wire on reels is often unsatisfactory, it should be stronger and ought to be inspected frequently.

When treating or radiographing nervous patients, children or those not likely to understand instructions, a sheet of strong canvas should be passed over the patient and fastened to the table so limiting movement as to prevent the patient from contact with line or tube by raising his arms or legs or by suddenly rising from the table. There is room for improvement in tube holders and terminal connections to assist in this matter. But even if this is done care must still be exercised, especially in deep therapy. The writer questions the advisability of deep therapy at as close a range as 8 inches. The terminals are as close as the target or may even be closer to the body. Further the ratio of deep dose-to-skin dose is much improved by working at greater target skin distance. Special terminals, such as described by Johnson, would help if not too cumbersome. A special screen might be developed if desired.

A quick acting circuit breaker should be inserted in the primary of *every* x-ray transformer. This should be set to act on not more than a 20 per cent overload. Thus if normal operation uses 35 amperes, then 42 amperes should open the breaker. Since on normal operation with a properly designed transformer nearly one milliampere tube current is secured for one ampere of primary current, it is not difficult to set a breaker for the largest current permitted. A short circuit through the body or otherwise would cause a primary current much above normal, thus opening the breaker.

Do not depend on line fuses. It takes time to raise a fuse to the melting point and delay is dangerous. They often stand a high overload for a long period without rupture.

If a double scale milliammeter is used it should be provided with an insulating device for changing the scale.

No complicated apparatus that will allow the terminals of the tube or the lines leading thereto to come near the patient or near to anything in contact with the patient should be permitted.

All switches should be self opening, requiring the operator to *hold them closed throughout an exposure, or treatment.* This should be done even though a time switch is used. Foot switches should not be constructed so as to lock or stick, but should open quickly and positively on release of pressure. Power switches should open down so that it would not be possible for them to fall shut.

Do not assume that a small outfit is essentially safe. One may be electrocuted by a small transformer if conditions are favorable, and he surely could be no more than killed on a large machine.

The rapidly increasing use of small transformer outfits with self-rectifying tubes for dental and bedside work demands special attention. There is danger from too close proximity to the lead wires, especially where both wires come near the patient or where one is near the patient and the other near metal, as in a metallic chair or metal bed. Also such outfits should never be operated by means of a foot switch. In two instances already reported to the writer an operator has been seriously shocked by some one acci-

dentally stepping on such a switch. Connections of the high tension wires to the tube should be substantial and certain. If one should become detached, unhooked or broken, it may put the patient in series with the tube, causing an unfortunate shock if nothing worse.

It must not be assumed that safety is *insured* by any *system of grounds* or special make of apparatus. In this connection the writer may call attention to the implication in the editorial section of the March issue of this JOURNAL that the American type of transformer is more dangerous because the "secondary high tension wires are in direct connection with the primary current through the transformer." As stated above there is *not* usually a direct or metallic connection between primary and secondary, and in any case the construction serves to avoid a potential to ground of more than one half of that operating the tube—a matter of considerable importance when operating at high gap as in deep therapy.

Ill advised grounding of electric power circuits may also cause a great deal of trouble and damage. The grounding of ordinary electric appliances such as transformer cases, conduits, panel board boxes, etc., has been worked out on the basis of long experience and is used to reduce risk in case of breakdown of insulation, accidental crossing of high and low tension wires, etc. Also where dampness or unusual conducting conditions are encountered lamp sockets and fixtures of special design are used further to protect the user and reduce fire risk. It is not permitted to ground a point on the active circuit except under very explicit conditions, since a second ground may be very dangerous. It follows that it is not wise to ground in the usual sense the case of an *x*-ray transformer. When it is done it should be through a suitable non-inductive resistance which will carry off surge or "static" without endangering the installation.

Aside from grounding for the real or supposed protection of the patient from discharge likely to endanger life, we have to consider the so-called static that often scares patients and troubles operators although not essentially dangerous. Whenever a high tension line is operated near insulated conducting bodies, such as metal plates, wires or the human body when on an insulating support, there will develop electric charges on these surfaces. The amount will depend on the area and proximity of the conductor, on the voltage of the line and somewhat on atmospheric conditions and the dryness of the walls and surfaces. When a person joined through more or less resistance to the earth, as the operator always is, approaches such a conductor, as for example the body of the patient, a brief spark discharge occurs. This is not painful or dangerous but tends to scare the patient and to suggest electrocution, *x*-ray burn, etc. It rarely occurs in radiography, but may be troublesome in treatment and fluoroscopy. In the latter it may be avoided by grounding the table if conducting, since the body is not between the tube and a grounded support. If trouble of this kind occurs in treatment it may be overcome by discharging the body through a pointed conductor connected to earth and brought near the body *after the operating switch has been opened*. There is rarely any difficulty of this kind in treatment, however, except where sheets of metal are used for protection and are so placed as to discharge to the skin, and this may be avoided by using felt or rubber between metal and skin.

There is an impression current among many that auto-transformer operation is essentially more dangerous than with resistance control. As is often true in other cases, a categorical statement of this kind cannot cover the facts. Keeping in mind that electrocution or serious injury may result from improper use with either control, there are two essential points to consider. When a tube is in operation at a given voltage the danger of spark-over to the patient is the same for both types of control, all conditions being alike. If an actual discharge to the body occurs the auto-transformer will maintain a larger current, and in that respect

be more dangerous; but the smaller current with the rheostat control may cause death or serious injury. Also when a circuit breaker is used it is likely to open much quicker with auto-transformer control than with rheostat, in part, at least, offsetting increased current by decreased duration. Even a moderate series resistance will delay the opening of a breaker somewhat.

In one important particular the rheostat control is much more dangerous than the autotransformer. Suppose a tube taking say 40 ma. at a 5 inch gap suddenly ceases to take current (a cranky gas tube, or a failure in the filament circuit on a Coolidge tube), with a rheostat control *the open circuit* or no current gap on this setting may be 10 or 12 inches, while with the autotransformer the difference between the 40 ma. and the no-current voltage may not exceed an inch. So that the danger of *starting* an arc by tube failure is much greater with the rheostat than with the other control, even though when once started the rheostat may be somewhat less dangerous because of lower current. This is of special importance when using a self-rectifying tube. The voltage of the suppressed wave will be very high on resistance control; hence an auto-transformer with a good circuit breaker is much safer with these tubes than is a rheostat.

Neither the precautions here mentioned nor indeed any formulation of rules or regulations can ensure safety to those concerned. But if they are followed they may help to avoid risk especially to those not familiar with the outfit who may be either patients or assistants. Nothing can relieve the roentgenologist in charge from the duty of knowing that reasonable precautions are taken and that every effort is exerted to secure protection. Neither are hospital authorities free from responsibility. They should not turn over equipment with such possibilities of danger to untrained people or accept advice only from those whose interest is exclusively in sales of apparatus.

Finally, medical colleges may some day come to realize that special training is needed for those who are to utilize such powerful agencies in their profession. It is quite true that there is not time to train all medical practitioners in all topics, but there should be provided opportunity for those who do specialize in radiology to secure adequate training. When this is accomplished this practice should be restricted to medical graduates who have, in *addition* to the regular medical course, such special training as is needed to increase both the usefulness of this agent and the safety of all concerned.

Note: The leaflet quoted in the March Journal issued by Messrs. Watson & Sons may be questioned in some important particulars at least as applied to American laboratories. The matter of grounding has been discussed above, so that paragraph 1 may be passed. All will agree with 2, 4, 10, 11, 13 and 14. The advice given in 3 is dangerous, as the rate of insulation deterioration leading to breakdown is often high and a feeling of false security is encouraged by *assuming* that such insulation protects.

As regards 5 there should never be any *high tension overhead wires.* The writer pointed out some years ago the great advantage of metal tubes. These should be mounted with care and well braced and should extend clear to the transformer terminals. The idea of stretched grounded wires below the overhead would not only be cumbersome but would fail by breaking when an arc results from contact, and would short-circuit the transformer—a very dangerous procedure.

Paragraph 7 is surely bad advice. The writer had occasion a few years ago to test hundreds of fuses. They will often carry an overload of 100 or 200 per cent for some time before blowing and sometimes not blow at all. A quick acting circuit breaker is infinitely better.

In reference to paragraph 8, why are the metal terminals of the *Coolidge* tube assumed to be any closer to the patient or more dangerous than those of any other tube when operated at the same control setting? As regards metallic gauze one may cite an instance in France where one of our grounding enthusiasts used a wet sheet over a patient with quite unexpected results.

RADIUM THERAPY*

By RUDOLPH MATAS, M.D.

Professor of Surgery, Tulane University
Senior, Department of Surgery, Touro Infirmary

NEW ORLEANS, LOUISIANA

As a surgeon and clinician, I am unavoidably and deeply concerned in the practical application of radium and in comparing its effects in the treatment of surgical diseases which, until recently, have been regarded as the undivided province of surgery. To this end, I have availed myself of every opportunity for observation in every case in which radium seemed to be indicated. I have endeavored to do so with an open mind, without prejudice, and without allowing my judgment to be influenced by preconceived ideas. I have enjoyed very fair opportunities for observation in the last five years, and particularly in the last four, since the organization of the Radium Institute at the Touro Infirmary has given us greater technical facilities with a fair supply of the radium material. In all, over 245 patients, suffering from various surgical diseases amenable to radium, have come under my personal care and supervision, with the valued cooperation of the radiologist of the institute, Dr. Samuels, and his associate, Dr. Bowie. As a result of this experience, I have been impressed with some facts, and have arrived at conclusions which in some instances amount to convictions. I should also add that my experience is limited to the radium salts and not to its emanations, as we have not yet established an emanation plant, though the directors of the Institute are so well impressed with the results obtained by emanation that we are seriously considering such a plant as a necessary addition to our resources. Lacking in this experience, we have been deprived of one of the most valuable methods of bringing the diseased tissue under the influence of radium and for this reason should be most cautious in basing our conclusions on the ordinary surface or inter-[illegible] methods of applying the element.

We have learned a great deal about radium and the radioactive substitutes in the last few years; but our knowledge of its therapeutic powers is still in a formative stage. The universal interest felt in radium and the vast sums that have been invested in this country alone to develop its clinical uses, as well as the great industrial impetus given to its production to meet the growing demand, are the best proof of the profound impression that radium therapy has made upon the leaders of the profession in the most active surgical centers. When we consider that only ten years ago radium as a practical therapeutic agent was regarded merely as a scientific curiosity, and, that in spite of all the demonstrations and eloquent pleading of Robert Abbe, he remained for nearly ten years its solitary champion and pioneer apostle in this country, the contrast with the present almost feverish ambition of every important clinic in this country to acquire radium is perhaps the best tribute that can be paid to its worth and efficiency.

It is, in fact, only now that we surgeons have come to realize that radium has become not only a powerful ally, but an actual rival of surgery, and that radium, when skillfully and judiciously applied, will often yield extraordinary cures where surgery often fails.

It is no longer a question whether radium is to be applied, for instance, in inoperable cancer, and only after surgery has failed, but whether it should not be given the preference at the start as the initial and only treatment. It is quite natural that at the present time many, if not the majority of surgeons are reluctant to surrender to the new therapy some of their choicest and most dearly conquered possessions. It is also evident in the present state of our knowledge, that radium

* [illegible] delivered by invitation at the Fifth Annual Meeting of The American Radium Society, New Orleans, La., April 26, 1920.

cannot cope with the great mass of the visceral cancers and other internal neoplastic diseases which are practically, if not absolutely, inaccessible to its action. On the other hand, it is quite clearly proven that whenever and wherever the morbid tissues can be brought fairly within the sphere of its influence, it can accomplish cures which are equal, if not superior, to those of surgery without any of its risks or fatalities. To arrive at conclusions in an absolutely fair and unprejudiced way is not always easy, as the interpretation of facts is so deeply influenced by the inclination and training of the observer. The pure technician and laboratory expert is likely to be too enthusiastic over the potentialities of radium; the surgeon, whose long training and skill have given him confidence in the outcome of his operations, is only too likely to depreciate its real value and to circumscribe its application by too many restrictions.

To attempt to cover all the conditions in which radium has been applied in our clinics either primarily, as the sole curative agent, or secondarily, as an adjuvant to surgery, would be impossible on this occasion. This can only be done in a detailed report of our work which is now in preparation. At this moment I can only touch in a cursory way upon some of the conditions in which my personal experience is sufficient to justify some conclusions.

In the first place, the angiomata or vascular tumors claim attention among the neoplastic diseases which have distinctly benefited by radium therapy. Practically all the members of this group, whether capillary, venous, cavernous, or erectile, and mixed, are more or less benefited by radium. But it is in the nevi or birth marks—"claret" and "port wine" spots—that spoil so many pretty faces by appearing in ugly patches in the most conspicuous parts (lids, lips, nose and cheeks), that radium displays its greatest curative powers. In dealing with the pure capillary nevi, or the coarser angiomata of a mixed type, when these appear on the face and neck, I believe that radium is entitled to the first consideration as the simplest, safest, and most efficient of our therapeutic agents. It is the only treatment that is effective without leaving a trace of disfigurement. The best results are obtained in new-born infants and in the younger children; in some instances the effect has been marvellous in the rapidity with which it has wiped out the blemish without leaving a trace of its action. In older patients the treatment is longer and less brilliant than in infants and young children. While radium must be regarded as the sovereign remedy for this class of angiomata, it sometimes fails, and we should be prepared for disappointments. I have now in mind a young woman of twenty-five years, who has a capillary nevus of a "port wine" color, which overspreads half her face like a mask. We have treated this girl systematically at different times for the past eight months by the method of divided and alternate squares which Wickham and Degrais so successfully practiced twenty years ago. In spite of this and at times more intensive treatment, to the extent of causing a superficial burn, the nevus has remained unaltered. The dosage of the radium and the method of application being the same as in the successful cases, the failure in this particular case can only be accounted for by an inherent resistance of the tissues, a hypo-radio sensibility or apparent immunity to the action of the radium rays. It is this peculiarity of certain individuals, which manifests itself in other tissues and in other ways, apart from the angiomata (fibroids, cancer, etc.), as we see in the different reaction of certain individuals to sunburn and other effects of the sun's rays, that makes it impossible to predicate with absolute certainty what the result of an initial radium application will be in any given case. Fortunately these experiences are exceptional and do not affect our general valuation of radium as a therapeutic agent, any more than of other valuable remedies which are known to vary in their action according to individual idiosyncrasies.

Another and more important group of tumors which is especially conspicuous as a beneficiary of radium therapy, is that consti-

tuted by the uterine fibroids and fibromyomata. Here radium has cut down my operations for this cause by over 60 per cent. In the last four years I have treated 63 uterine fibroids with radium, and with the exception of four cases, all have been treated exclusively and successfully by this agent. In three cases, hysteromyomectomy had to be performed on account of the secondary necrotic degeneration of the tumor mass following the intensive action of radium. In another case, owing to the great mechanical difficulty in applying the radium into the uterine canal, roentgentherapy has been substituted after several applications, which, however, had succeeded in supressing the menstrual flow. This patient is still under observation, though free from complaints. All the others have recovered, or, at least, are symptomatically cured. The best results have been obtained in the soft, rapidly growing intramural myomas. The effect of radium upon some of these masses is sometimes marvellous. The bleeding stops and the tissues undergo a rapid atrophic change in an astonishingly short time. Some of these tumors, of such large size that they reach to the umbilicus and fill the pelvis, show by their rapid diminution that the action of radium is exercised primarily upon the vascular supply of the uterus, and that the atrophy is due to the ischemia induced by the degeneration and blocking effect on the uterine circulation. But it is this very effect that compels the greatest caution in the application of the initial doses. An overdose of radium may bring about a rapid necrosis of the mass which is followed by toxic phenomena from the too rapid absorption of the dead tissues. The larger the growth the more cautious should we be in our initial treatment. In cases where a febrile reaction occurs, with nausea and vomiting, and other evidences of toxic absorption, these phenomena are not caused by bacterial infection, but are simply significant of a toxemia from pure necrotic absorption. It is surprising to observe how nature succeeds in eliminating these large dead or dying masses. I have in mind a recent experience in which the patient was rendered extremely anemic and weak from profuse and intractable hemorrhages caused by a very large and rapidly growing fibromyoma (about the size of a five months' pregnancy). The hemorrhage was very profuse and we were compelled to use 100 milligrams for 12 hours, repeatedly, before it could be checked. When this was arrested, chills and fever developed—103° and 104°, followed by quotidian intermittencies for over a week. This patient had been in a malarial district, and we thought the chills might be of malarial origin, but the blood showed no evidence of plasmodia. There was no marked leucocytosis. She was given quinine, however, and just as I had decided to operate the fever gradually subsided. The changes in the uterus following the arrest of the hemorrhage, and just as the febrile movement had begun, were extraordinary. The uterus became turgid, swollen, and edematous, and the cervix elongated until it almost projected from the vagina, and a profuse mucoserous drainage flowed from the external os. The local effect was very much like that which would follow the sting of a venomous reptile. With the subsidence of the fever, the local edema and swelling of the uterine tumor also subsided, and, when the patient came back to see me two months later, the uterus had been reduced to the size of a pear, it was normal in size, mobility, and position, and the general improvement was such that the patient was scarcely recognizable.

With increasing experience and better technic, these violent reactions which were very alarming in the earlier cases, have notably diminished, though a mild type of "radium sickness" (low temperature, nausea, bad taste, and general myalgias, etc.) still remain at times as evidence of necrobiosis and excessive dosage.

In the selection of cases, we have found that the multiple subperitoneal and pediculated fibroids, and the very hard, sclerotic, and partially calcified fibroids, are the least influenced by radium; the intramural and

submucous fibroids are most amenable to its action. Radium is never applied to cases of doubtful diagnosis or when complicated by pelvic infection in any form, with ovarian cysts, or other abdominal lesions which can only be relieved by surgical treatment. In all profoundly anemic patients, who have been exhausted by profuse and prolonged hemorrhages, radium is always applied for the hemostatic action which it exercises on the endometrium, regardless of the cause of the metrorrhagia. Probably the greatest benefit from radium has come to that class of patients who, rendered profoundly anemic and exhausted by bleeding fibroids, are unfit for surgical relief on account of complicating diseases, such as chronic or acute nephritis, advanced cardiac or pulmonary lesions, hyperthyroidism, etc. I do not believe that the mere size of the tumor is a contraindication to radium, provided it is an intramural growth of the soft, rapidly growing, bleeding type in which the uterine canal is elongated sufficiently to allow the radium to be deposited in its interior.

The relation of the cure of fibroids by radium to menstruation, the premature menopause and sterility, is still a controverted question. Is it necessary that the menstrual function should be permanently arrested and that the premature menopause should be brought about to cure the fibroids? Without attempting any generalization, but merely as a bald fact, I would state that thus far I have treated 78 cases of metrorrhagia with radium. Of these 64 were caused by fibromyomata and 14 were of the so-called "essential" type (non-neoplastic). The majority were married women, and the greater proportion were within the reproductive age. Thus far in no case has conception occurred, at least during the last four years. This includes patients who have been treated in the last six months. It would, therefore, be altogether premature to arrive at any conclusions apart from the mere statement of the gross fact. On one point I entertain a definite conviction, and that is that no uterine fibromyoma of sufficient size to be easily palpated and to cause symptoms and especially metrorrhagia, can be cured in any permanent sense without bringing about a total suppression of the menstrual function—in other words, by inducing the atrophic and involution changes of the menopause. As long as the flow continues with regular or irregular periodicity, and no matter how scant, the growth of the tumor is not under control. It is only when the menses are completely arrested that we have the first assurance of the effectiveness of the radium treatment.

In dealing with the metrorrhagias of puberty, so-called, of the menopause, or of the middle period, for which granular metritis or other endometrial pathology is responsible, radium is the sovereign remedy when all the classical treatments have failed. In these I believe it is possible to bring about, by proper radium dosage, a complete amenorrhea without necessarily inducing the ovarian changes of the artificial climateric. In these, a return of the normal menses with the preservation of the ovarian function may, and no doubt does, occur. But in my experience the cases of metrorrhagia requiring radium to check them have been so severe that the dosage required has been as intensive and prolonged as that which I have used to induce atrophic changes in fibroids. In consequence, the radium amenorrhea has been permanent in every case, though it is possible that in the younger women there may be a return of the flow in spite of the lapse of two and three years.

One observation I feel confident will be borne out by future experience, and that is that as long as the radium amenorrhea lasts there will be no conception. Whether the sterility caused by radium is due to degenerative changes in the uterus or in the ovary, or both, I am not prepared to discuss; but it is my belief that radium applied to the uterus in the usual way exercises its influence chiefly and primarily, if not solely, through its local effect on the uterine circulation, and that its radiations are more likely to spare the ovaries which are usually beyond the sphere of its direct action.

It is well known that the most eminent radiologists (M. Béclère, for instance) aim at the ovaries with x-ray radiations, with the intention of bringing about the cure of fibroids by the suppression of ovarian function. And yet it would seem much more difficult to spare the ovaries by roentgentherapy than by radium, in view of the difficulty, if not practical impossibility, of limiting the x-rays to definite, circumscribed areas, especially when the target aimed at (the ovaries) is in the dark, and its location—especially when uterine fibroids are the object of the treatment—is more than problematical. In this connection the recent communication of M. Ménard, radiologist of the Cochin Hospital, (Société de Chirurgie, Paris, Feb. 17, 1920) who reported three cases of pregnancy occurring in the course of the radiologic treatment of fibroids, is of unusual interest. M. Ménard reports these cases to prove that—contrary to M. Béclère's and the general belief—fibroids can be successfully treated by radiotherapy (x-rays) without interfering with conception or a normal pregnancy. In the firs tcase, the patient had been radiated eight times during the first month of gestation before pregnancy was discovered—in all she had been radiated fourteen times; in the second, eleven radiations during the first four months of gestation, eighteen times in all; and in the third, six radiations after pregnancy had occurred and thirty-five sittings in all. The first two had gone through a normal gestation and labor, with the birth of perfectly normal children; in the third, pregnancy was propressing normally in every way and she was expecting delivery when the report was published. In the first two cases, the patients were apparently normal when examined four years after their delivery. In the first case, the normal menses appeared six weeks after childbirth; in the second, five weeks after the confinement. The diagnosis and details as to the size and character of the fibroids are not given because M. Ménard, acting merely as a radiologist, had accepted the diagnosis made by a competent gynecologist. These are certainly extraordinary observations, and they are remarkable chiefly because of their exceptional and rare occurrence. Whatever their bearing upon the x-ray therapy of fibroids, they certainly cannot apply to radium which, by virtue alone of the intra-uterine application of the element, would surely interrupt the progress of a normal gestation.

Be this as it may, I believe that no one who has a fair opportunity for comparing the relative merits of roentgen with curie therapy will gainsay that radium is by far the more effective, certain and rapid of the two methods; and whoever has practiced with radium (in fibroids) will not go back to the x-rays except in very unusual circumstances or when radium is not available. I know that Béclère has recently reported 386 cures of uterine fibroids out of 400 cases, all cured by radiotherapy alone; but, without questioning his figures, I would only remind you that in spite of the fact that France is the birthplace of radium therapy, radium is scarce in France and has only come into gynecologic practice in very recent times; in fact, only since the war. But even now some of the most eminent French gynecologists (M. Faure, for instance) speak as if a new era had dawned in the treatment of fibroids since the introduction of radium. Personally I would express my conviction in regard to the superiority of radium, by saying, that in the case of one of my family, my wife, my daughter, or some one over whom I had authority, or for whom I felt a direct responsibility, I would unhesitatingly look to radium as my first choice. In the light of my surgical experience, I deem it safe to estimate the average mortality of uncomplicated hysteromyectomies at 4 per cent, even in the most skilled hands. But even if the mortality were reduced to 1 per cent, I would still deem it my duty to try radium first, as the easier, safer, and more benign mode of cure, and the one that would impose the least hardship on my patient. It is understood that I am speaking of uncomplicated fibroids of the recognized type for radium treatment.

So much time has been consumed in the discussion of the radium therapy of fibroids that little is left for the most important phase of the subject—the treatment of uterine cancer. My remarks will therefore be briefly limited to the impressions gathered from the study of 45 of the uterine patients who have come under my personal observation, exclusive of 77 malignant cases which have been treated in other organs or localities. The majority of these uterine cancers have involved the cervix, and a small proportion have represented the fundal type. The majority have been referred to me after recurrence following hysterectomy by other operators.

In my own practice the fundal cases have all been subjected to a total hysterectomy after a preliminary curettage and a single intensive radiation for prophylactic purposes, with the hope of preventing metastasis. These (5 cases) have all done well, though the period of probation has not exceeded a maximum of four years and a minimum of five months. I can only say in regard to one fundus case which came to me in an advanced septic state, with pyometra from atresia of the external os, and with complete fixation of the uterus and general parametrial infiltration, that the prolonged application of radium in large doses, 100 milligrams for twenty-four hours repeated at short intervals after a preliminary curettage, brought about a perfect symptomatic cure which has continued to the present time, or nearly four and a half years. In dealing with the cervical carcinomata in their incipiency, I preferred in earlier years to apply a heavy dose of radium for twenty-four hours and follow this by a total hysterectomy; but lately I have gradually come to depend upon radium exclusively, as the results seemed to me far better from the point of view of permanency of cure than in the advanced and inoperable cases. The number of these incipient cases treated exclusively by radium is yet too small and the time that has elapsed too short to assert a positive cure. However, I have now under observation five cases in which cervical carcinomata, demonstrated as such by histological examination, have remained symptomatically well for a minimum period of four months and a maximum of three years.

Judging by the usual symptomatic benefit obtained in some of the most hopeless cases that have come under my care after the failure (recurrence) of the most radical operations, it seems to me only logical to conclude that the chance of permanent cure by radium in incipient or early cases would be infinitely greater than in the advanced inoperable cases.

It is, again, my conviction that in cervical carcinoma, if radium is applied before metastasis has occurred, a cure will be obtained which is more certain in a permanent sense than can be obtained by surgery. In the advanced postoperative recurrences, metastasis has, as a rule, already occurred in regions which are entirely beyond the zone of radium influence. For this reason the brilliant results obtained in this group are only temporary and the vast majority ultimately die of cancer. In dealing with cancer, more so than with fibroids and other neoplastic tissues, it is a matter of common observation that whenever recurrence occurs after an apparent radium cure, the reapplication of the element appears to exercise little or no controlling influence. The neoplastic tissues appear then to have acquired a sort of immunity against radium which makes them absolutely refractory to all further treatment.

In other localities, as in the breast, where the metastases are generally external and visible, the pursuit of these with radium exerts a checking and controlling influence which is denied in the pelvic and in the visceral organs.

After reviewing my experience with carcinoma of the uterus, and especially of the cervix, I have come to the conclusion that the greatest hope of cure offered by radium lies in the primary application of this agent in the very earliest stage of the disease, when the neoplastic area is well defined and cir-

cumscribed, and before metastasis has occurred. Then we may reasonably expect a cure and not, as happens now, when radium is applied as a last resort after recurrence and wide dissemination have demonstrated the failure of the knife.

But even in these inoperable and recurrent cases the relief given by radium is, as all must admit, a blessing of incalculable good. Nothing in the long history of cancer therapeutics can compare with the splendor of its action in transforming a life of suffering and despair into one of relief, relative comfort and cheerfulness. But it is at this stage that we must be most cautious in our prognosis, and not allow ourselves to be caught in the general enthusiasm that follows this marvellous improvement that so often simulates a cure. The public should understand that in advanced recurrent and metastatic cancer these symptomatic cures are only of temporary duration and that, ultimately, the disease will assert itself and claim its victim. On the other hand, the relief obtained, which may continue for months and years, still gives to radium the supremacy over all palliative remedies in the treatment of uterine cancer.

[The stenographic report of this address has been revised and in many parts rewritten for publication, but without altering the meaning or purport of the verbal message. R. M.]

A NEW METHOD OF MOUNTING INTENSIFYING SCREENS

By ROBERT T. MORRISON

Eastman Kodak Company

ROCHESTER, NEW YORK

In attaching screens to cassettes, a common practice is to apply a drop of glue at each corner and at several points along each edge, between the screen and the cover of the cassette. Most cassettes have a layer of felt interposed between the screen and the cover of the cassette, in which case the felt is glued to the metal cover and the screen in turn is glued to the felt. While this method is perhaps the most convenient for the average user, it has several objections.

The chief defect in the present method is the uneven screen surface which occurs in the regions where the glue has been applied. In the case where the screen is glued directly to the metal, the expansion of the screen may cause it to buckle between the spots where it is held by the glue. Where felt is used, small convex areas are formed on the screen surface by the spots of glue. Tests have shown that any unevenness in the screen surface results in impaired definition, due to the poor contact between the screen and the sensitized material. The loss of definition may be demonstrated by radiographing a wire screen placed on the cassette.

Glue is not fully satisfactory in that it does not permanently hold the screen in the cassette, especially where felt is used between the screen and the metal cover of the cassette. In addition, small particles often chip off from the hard dry glue and ultimately some of them reach the screen surface or surfaces where they either adhere to or scratch the delicate surface of the screen.

It has been suggested that screens might be mounted in cassettes with dry mounting tissue, which is used ordinarily with a hot iron or press for mounting photographic prints. To determine the feasibility of this method, especially in regard to overcoming the present faults, the following tests were made.

The first experiment was an attempt to mount an 8 by 10 screen on a flat aluminum plate of the same linear dimensions and ⅛ inch thick. Two layers of dry mounting tissue were inserted between the screen and the

plate and the whole placed in a dry mounting press, the heat being applied to the aluminum plate. The sensitive surface of the screen had been protected with a sheet of paper. In a few minutes after applying the heat, the screen was firmly attached to the plate over its entire area.

In another experiment the heat was applied to the intensifying screen surface instead of to the metal plate. The dry mounting press was cold to start with, and the heating current was turned on after the screen and metal plate had been clamped in position. By this method the screen was heated gradually, and the screen and plate were satisfactorily cemented together without any damage to the screen. However, subsequent experiments showed that the screen may be seriously damaged by applying the hot plate or iron directly to its sensitive surface; therefore such a procedure is not to be recommended.

Next, an attempt was made to mount the screen with felt between it and the metal plate. Dry mounting tissue was placed between the felt and the screen, and between the felt and the aluminum plate, and the whole inserted in the dry mounting press with the heat applied to the metal plate. The results were entirely satisfactory, the screen, felt and plate being firmly fastened together.

The next effort was to mount a screen in a cassette with an electric iron instead of the dry mounting press. Mounting the screen directly on the metal required a longer time with the electric iron, but the results were entirely satisfactory. Where felt was interposed between the screen and the metal, the method presented some difficulties because of the rapidity with which the heat was radiated from the metal cover of the cassette. The best results were obtained when only a number of spots, instead of the entire surface, were covered with tissue and the heat applied to them. In the case under consideration, i.e., using an 8 by 10 cassette, small pieces of tissue (double layer), about 1½ inches on a side, were placed in each corner and one in the center. By placing the iron over each area in succession for a sufficient length of time (about ten minutes), the desired result was obtained with felt between the screen and the cassette. This method is not practicable where the cassette cover is painted, since the heat required is sufficient to damage the paint. Screens mounted this way were easily removed by heating sufficiently and separating the two elements while still warm.

These tests show that the use of mounting tissue to cement screens in cassettes is practical, and overcomes some of the faults of the present method of mounting. There is a saving in time also, since the cassettes can be used as soon as they are cool, whereas if glue is used considerably longer time must elapse for the glue to dry.

In using this method precautions should be exercised to prevent damage to the screen. It is not safe to apply the heating element directly to the screen surface. If the temperature of the screen is increased gradually and uniformly over the surface, such as takes place when the heat is applied by an electric iron on the metal cover, the screen does not suffer any damage. The heating should be discontinued when the melting point of the tissue (approximately 140° F.) has been reached. This can be determined by an occasional observation made by slightly separating the screen from the support during the process. This method is perhaps more troublesome than the use of glue in attaching screens in cassettes, but it gives better results. It produces no unevenness in the screen surface, fastens the screen firmly to the cassette, and allows the screen to be readily removed when it is necessary to replace it.

This method was first suggested to us by Mr. Otto Doehn of Cleveland, to whom due acknowledgement is made.

A STEREOFLUOROSCOPE*

By STANTON HECK, M.D.

SALEM, OHIO

GRANTING that the Coolidge tube has made possible a practical stereofluoroscope, its absence from the roentgen laboratory of the average modern hospital is evidence that it has not yet reached a satisfactory form. To promote and hasten its development is the object of this paper.

You are all familiar with the theory of the stereofluoroscope first demonstrated by Mackenzie Davidson years ago. The instrument I am about to describe is yet far from perfect. We have in Fig. 1 a front elevation showing the relation between the tubes, screen and eye points. The anode screen distance is 20 inches, double the eye screen distance of 10 inches. The distance between the anodes is 5 inches, or double the pupillary distance of 2½ inches. This arrangement of having the anode screen distance greater than the eye screen distance and making the distance between the anodes bear a corresponding ratio to the pupillary distance, places the patient at a favorable point for operation or manipulation, and at the same time prevents unfavorable distortion or blurring of the image.

In support of this contention, some exposures are here presented of a cube of wood containing screws and tacks. Fig. A is a lateral exposure, showing the actual distance between objects. In the stereoscopic exposure the cube is placed 2 inches from the plate. The small lead oval is in contact with the plate. The images are so placed that when viewed by direct vision the pseudo-image is presented. This is the image seen in the stereofluoroscope. When viewed in the ordinary hand stereoscope the normal image is seen. When viewed at the same distance by either method the depth values remain the same. In Fig. B the anode plate distance is 12 inches, tube shift 2½ inches. When viewed at 12 inch depth, values are normal. The outline of objects is somewhat blurred. In Fig. C the anode plate distance is 36 inches, tube shift 2½ inches. When viewed at 12 inch depth values are much lessened. When viewed at 36 inch depth values become normal. Notice the sharp definition due to long tube-plate distance. In Fig. D the anode plate distance is 36 inches, tube shift 7½ inches. When viewed at 12 inch depth values are normal.

The side elevation shows the eye-point outside the cone of direct rays from the tube. This arrangement, while protecting the eyes and placing the observer in a comfortable position, does not seriously distort the image.

The shutter consists of two revolving discs 6½ inches in diameter. Their centers are 8 inches apart. A concentric strip ¾ inch wide is removed from somewhat less than half the circumference of each. When this space passes in front of the eye-hole of the face plate it allows the corresponding eye to see the screen, and at the same time the other eye is shut off by the intact portion of the circumference on the other disc. In front of the shutter is a metallic face-plate having openings corresponding to the position of the observer's eyes, and a depression in the center and below for the nose and mouth.

Fig. 2 shows a rotary switch, the moving part consisting of a shaft mounting a 12 inch arm. The shaft lies in the same plane and parallel with the shafts on which the shutter disks are mounted. The shutter disks and switch rotate in the same direction and at the same rate of speed through a suitable gear connection. An electric motor drives this system at a speed of 900 revolutions a minute, by a belt running over a pulley on the switch shaft. By this means the eye gets fifteen light impressions per second. The arm

*Read at Twentieth Annual Meeting of The American Roentgen Ray Society, Saratoga Springs, N. Y., Sept. 3–6, 1919.

carries the high tension current, and its extremity travels close to two semi-circular rods, each of which is connected to one of the Coolidge tubes.

ameters, and in front the control rheostats.

Fig. 4 shows the table for the patient, which is mounted on castors. Its top is a canvas-covered stretcher. Each end of the stretcher rests on a support with 10 inches of vertical adjustment. This is accomplished by a rack engaging with a spiral pinion. In an earlier model than the present one, the shut-

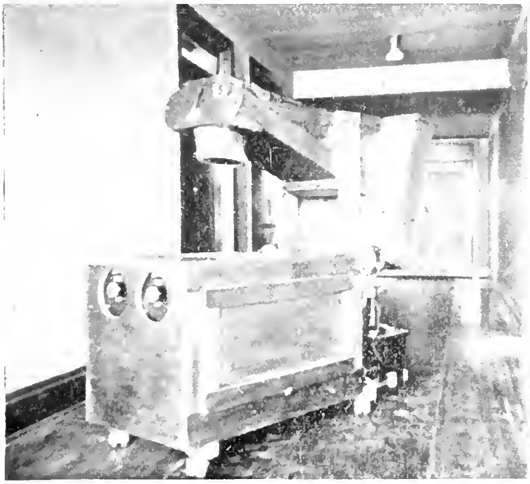


Fig. 1. Dr. Heck's Stereoscopic Fluoroscope. View of Front End and Right-hand Side.

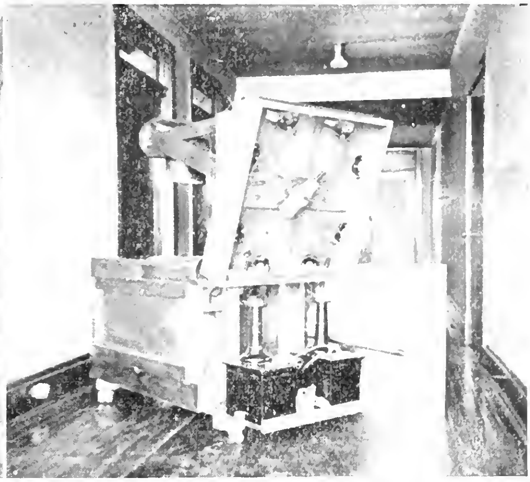


Fig. 2. View of Rear End, Showing Rotary Switch. Cover Removed and Standing on the Floor.

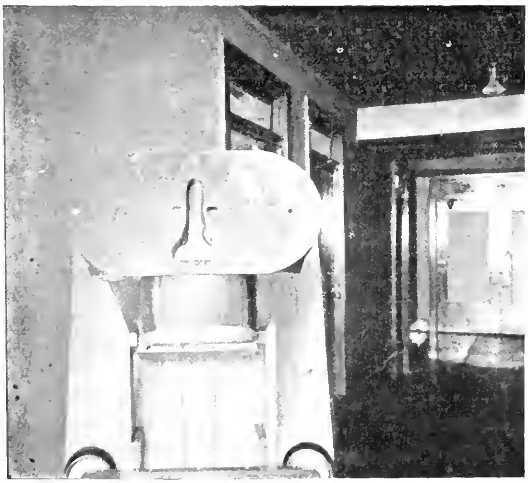


Fig. 3. Close-up View of Eye-Piece. Note depression for nose and mouth and that one shutter is open and the other closed.

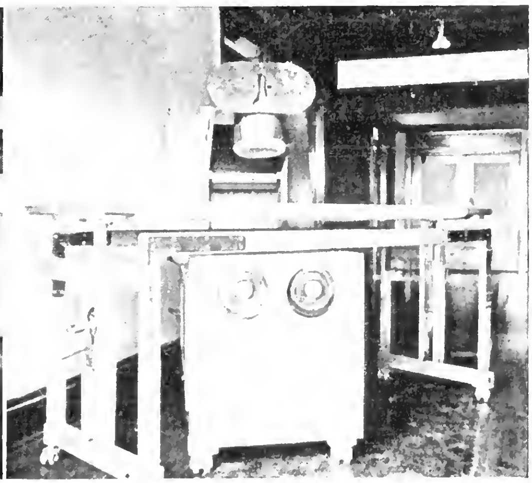
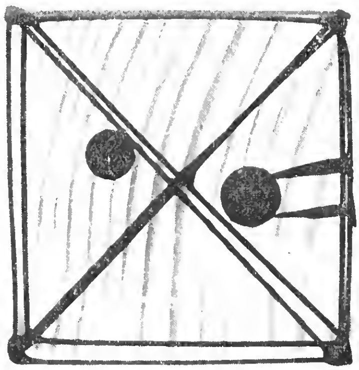


Fig. 4. Showing the Adjustable Stretcher in Position.

Fig. 3 shows, on its upper portion, the screen and face plate with its nose depression and eye-holes. Behind is seen the Coolidge filament transformers and their milli-

ter and switch are on the same shaft, but the present contrivance amounts to the same thing.

In the development of this instrument, the writer is under obligations to many persons for suggestions and material assistance, especially to Dr. W. D. Coolidge, and to Mr. W. H. Mullins of Salem, Ohio.



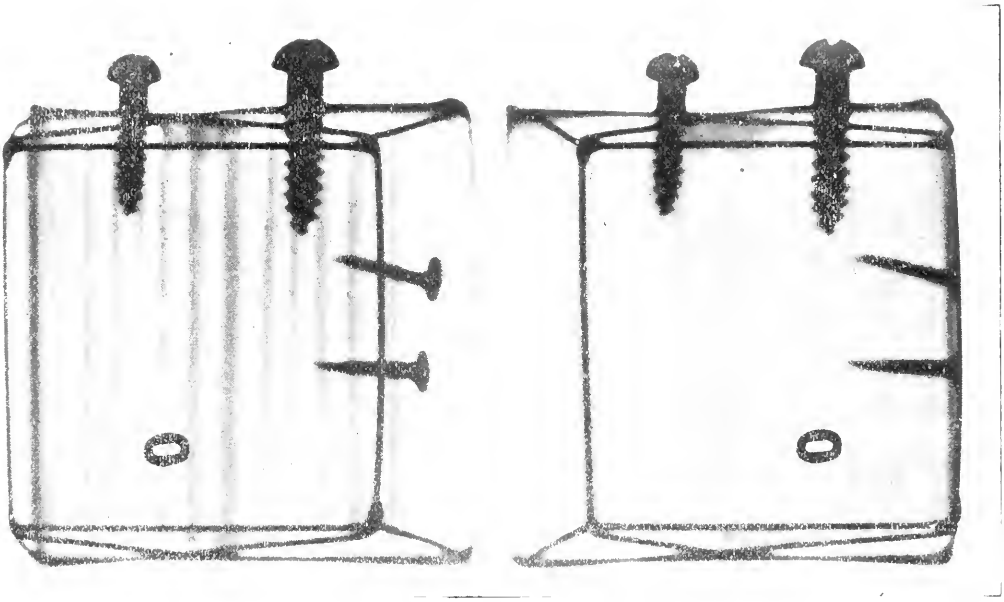
A

DISCUSSION

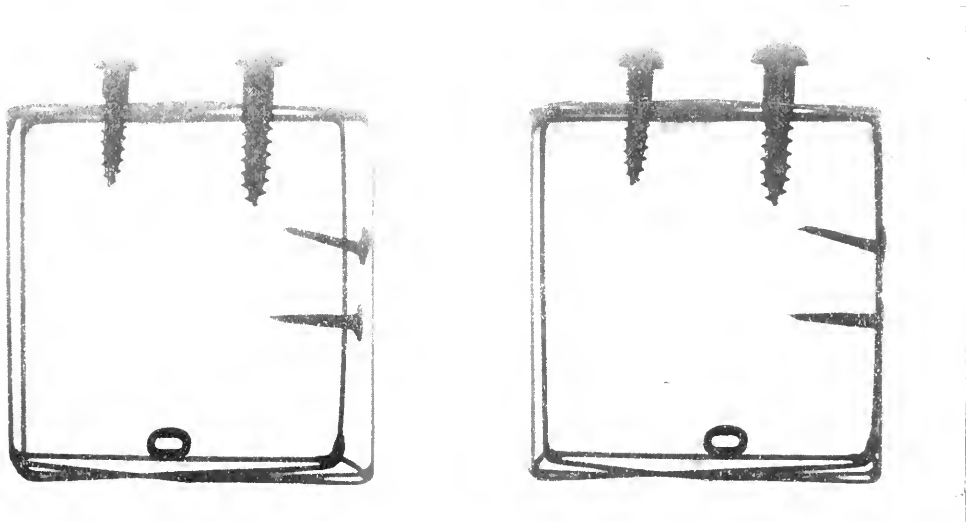
Dr. David R. Bowen.—The engaging thing about Dr. Heck's fluoroscope is that when one goes into his laboratory to see it, there is an entire absence of fuss and feathers. He just rolls it into the middle of the floor, hooks it up and then it works. Just what practical use he has been able to make of it I do not know; but Dr. Heck has displayed so much ingenuity and originality in working out the details of this apparatus that I do not believe any history of the stereoscopic fluoroscope can be considered complete unless it mentions this very interesting apparatus of Dr. Heck.

Dr. W. D. Coolidge.—I want to say a word by way of appreciation of Dr. Heck's work. I went to Salem to see his stereofluoroscopic apparatus and was very much impressed by it. I feel that in the future development of this method, we are, perhaps, more likely to use self-rectifying x-ray tubes and a single synchronous motor-driven shutter. But this much must be said of Dr. Heck's apparatus as it was when I saw it—it worked, it was brutally simple and it could not get out of synchronism.

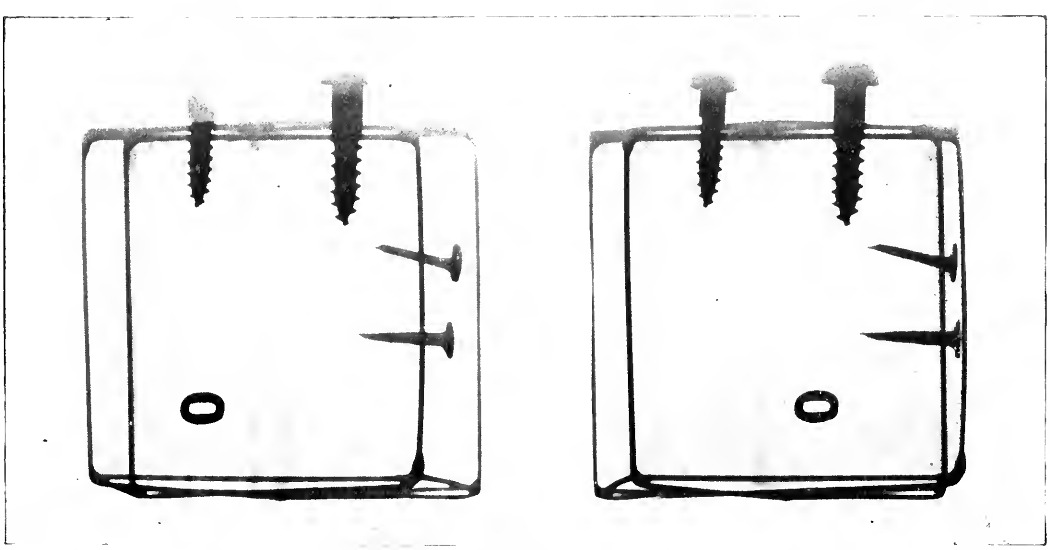
I felt then, and still feel, that this apparatus was good enough as it stood to enable one to answer the question, which is apparently still unanswered, as to whether a mechanically and electrically perfect stereofluoroscope could or could not be usefully applied.



B



C



D

X-RAY STUDIES IN GOUT

By E. D. McCARTY

Radiographic Department, Peter Bent Brigham Hospital

BOSTON, MASSACHUSETTS

RADIOGRAPHIC studies of the hands and feet of gouty subjects have been made by Huber,[1] Drinberg,[2] Strangeways,[3] Jacobson [4] and others. With the exception of Huber and Strangeways all authors have considered certain radiographic findings to be pathognomonic evidence of gout. The present study was made for the purpose of attempting to determine whether the diagnosis of gout was justifiable upon the basis of the findings of these investigators. For this purpose the plates of the hands and feet of nine cases of tophaceous gout have been studied. The findings are given in the following protocols.

CASE I. J. G., Med. No. 5421. White, male, aged forty-three. Diagnosis: Gout; tophi; arteriosclerosis; hypertension; chronic myocarditis; very questionable chronic nephritis.

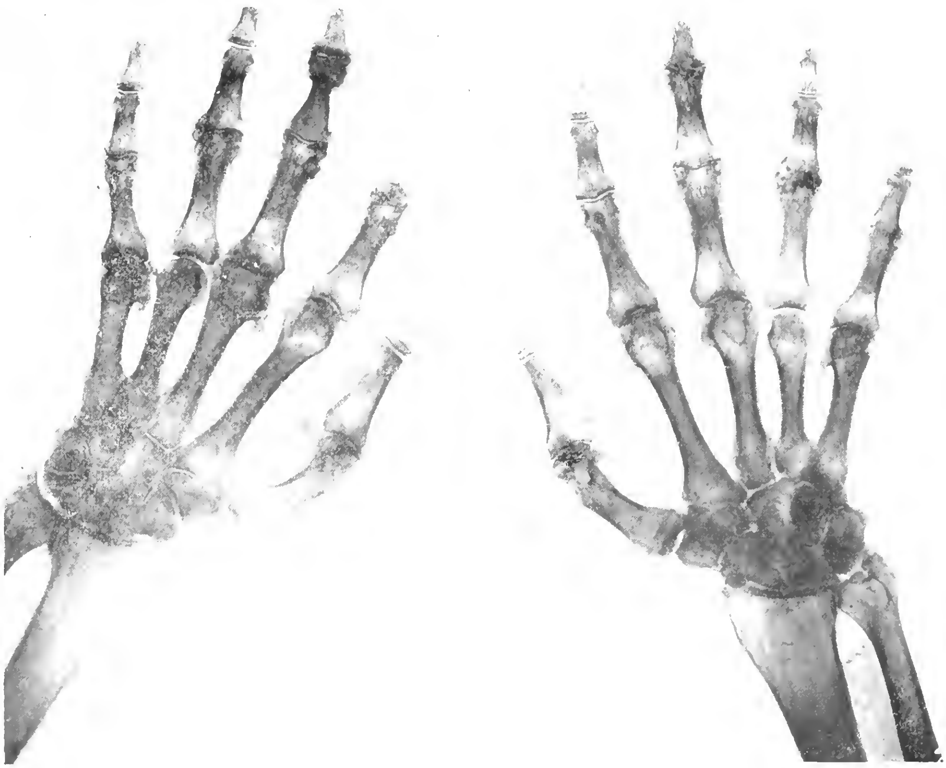


FIG. 1. CASE I.

ROENTGEN REPORT NO. 8140

Hands and wrists: There is moderate bony atrophy of the lower ends of the radii, ulnae, all the bones of the carpi, metacarpi and phalanges. Proliferative changes involve most of the articular ends of the phalanges and of the distal ends of the metacarpals. The bones of the wrists show mottling, due to small areas of decreased and increased density. All the joint spaces of the wrists are narrowed and there is some irregularity in outline of the articular surfaces of the bones.

The heads of the metacarpal bones, except the fourth metacarpals, of both hands show spur formation and more or less mottling. The metacarpo-phalangeal articular surfaces of the bones are irregular in outline. The articular margins show variable degrees of increased density and the corresponding joint spaces are narrowed. These changes are most pronounced in the metacarpo-phalangeal joint of the right middle finger, the articular surfaces being completely destroyed and replaced by an irregular density. The metacarpo-phalangeal joint of the right ring finger is normal except for slight narrowing of the joint space. The interphalangeal joints present various degrees of the same processes. Some of the interphalangeal joints described in the metacarpo-phalangeal joints are normal in appearance. Others, especially the proximal interphalangeal joints of the fourth and fifth phalanges of the left hand, are more or less obliterated and replaced by deposits of increased density with proliferative changes (lipping and spur formation). The shaft of the middle phalanx of the middle finger of the right hand is narrowed. There are numerous, more or less circular, frequently fairly well defined focal areas of decreased density, localized mostly in the heads of the metacarpal and phalangeal bones.

The soft tissues of the fingers show irregular nodular thickenings. The larger arteries of the forearms and wrists are visible.

Fig. 2. Case I.

Feet: The plantar arches are high. There is a moderate amount of bony atrophy of all the bones of the feet. The tarsal bones present a mottled appearance due to small areas of alternating increased and decreased density. The tarsal joint spaces are narrowed; some of them are obliterated and replaced by irregular lines of increased density. All these changes are more pronounced in the left foot. The heads of both first

metatarsal bones are mottled. The margins of their phalangeal articular surfaces show lipping and the corresponding joint spaces are narrowed. The head of the second metatarsal bone of the right foot shows proliferative changes. The heads of both fifth metatarsal bones are irregular in outline. The articulating surfaces of the bones forming the metatarso-phalangeal joints of both fifth metatarsals are irregular in outline. There is partial subluxation of the bones of the fifth metatarso-phalangeal joint of the right foot. The rest of the metatarso-phalangeal joint spaces show varying degrees of narrowing. The interphalangeal joint spaces of the halluces are narrowed and there is lipping at the margins of the articular surfaces. Both great toes show a moderate degree of hallux valgus.

In the heads of both first, both fifth and the right second metatarsal bones are focal areas of decreased density. The latter tend to be circular in outline, the borders are more or less well-defined and vary in diameter from one to five millimeters. The soft tissues in the regions of the first and fifth metatarso-phalangeal articulation of both feet show slight nodular thickening. The larger arteries of the feet are visible.

Summary of the radiographic findings: The changes found are atrophic, proliferative and destructive in type. Certain bones and their joint surfaces are involved in these changes while others are normal or nearly normal. Some of the joint spaces are obliterated and ankylosis has occurred in certain of them. There is partial subluxation of one joint. There are focal areas of decreased density in some of the bones. The regions in which these areas occur usually show other bony changes. Nodular thickening of the soft tissues and arteriosclerosis of the larger vessels are present.

Fig. 3. Case II.

Case 2. W. P. G. Med No. 5471. Negro,

male, aged forty-three. X-ray No. 8225. Diagnosis: Gout; tophi; questionable chronic nephritis.

ROENTGEN REPORT NO. 8225

Feet: In the examination of the feet all bones of both feet show slight bone atrophy. The right foot shows slight hallux valgus with narrowing and slight roughing of the first metatarso-phalangeal joint. The proximal phalanx of the right great toe shows increased density of the proximal end. The left metatarsal joint shows slight lipping of the base. In the head of the right first metatarsal bone and proximal phalynx of the great toe right cuboid, are circumscribed, punched-out areas of decreased density, the first metatarso-phalangeal joint being involved. The head of the left first metatarsal bone presents an area of decreased density, the borders of which are diffuse.

In the examination of the hands all the changes are remarkably symmetrical. There [illegible] nodular swellings of the soft tissues of all the phalanges except the third, and there is slight bone atrophy of all the bones of the hands and wrists which is more pronounced in the right hand.

Both thumbs show proliferation about the distal joint, the right presenting the greater change. In the head of the proximal phalanx of the left thumb there is an area of decreased density.

The distal end of the second phalanx of the left index finger presents an area of decreased density and obliteration of the distal joint. The distal joint of the left third finger is narrowed and irregular in outline. Both little fingers show punched out areas of decreased density in the second phalanges, the joint space in the left being irregular and narrowed. The corresponding joint on the right is entirely destroyed, the process involving the distal and proximal phalanges.

There is an area of decreased density near the styloid process of the left ulna and styloid process is blunted. The right ulna also shows the beginning of a similar change. The base of the proximal phalanyx of the second finger of the right hand shows a

FIG. 4. CASE II.

notched appearance. Bruce's nodes are present in the first, second and third fingers of the left hand and in the first and fifth of the right.

Summary of the radiographic findings: The changes are atrophic, destructive and somewhat symmetrical, with very few proliferative changes. The destructive changes are of the nature of small, punched-out areas of decreased density, the exception being the right little finger where the joint is also destroyed, apparently due to extension of an area of decreased density involving this part.

Fig. 5. Case III.

Fig. 6. Case III.

Case 3. G. W. L. Med. No. 2929. White, male, aged sixty-eight. X-ray No. 210. Diagnosis: Gout; tophi.

Hands: In the examination of the hands the right five and the left second and fourth fingers show marked nodular thickening of the soft parts. The third finger of the right hand has been amputated proximal to the distal phalangeal joint. Bone atrophy is present in varying degrees in all the phalanges and in the bones in the region of the nodular thickenings are many exostoses, the bones themselves showing circular and irregular areas of decreased density. The phalangeal joints in these regions show narrowing of the joint spaces, the articulating surfaces of some of these joints being irregular in outline with some destruction of the condyles with consequent distortion of the member. Many of the other phalangeal joints show narrowing of the joint space. The heads of the third and fourth right metacarpal bones present spur formation on the mesial margins with slight narrowing of the corresponding joint space. The remainder of the metacarpal bone and the bones of the wrists show no definite changes.

Feet: The left fourth toe is missing distal

to the middle of the proximal phalanx. There is slight hallux valgus in both feet. The bones of the feet show bone atrophy. The heads of both first metacarpal bones show slight proliferative changes and punched-out areas of decreased density. Both metatarso-phalangeal joints show slight narrowing of the joint spaces, also proliferative changes. The articulating surfaces of these joints are irregular in outline. The heads of both fifth metatarsal bones are irregular in outline, the irregularity presenting a mottled appearance. The joint spaces are narrowed with no evidence of proliferative changes. The articulating surfaces of the proximal phalanx of this joint are not irregular. The second phalanx of both fifth toes show punched-out areas of decreased density.

Summary of the radiographic findings: The feet show principally bone changes, the punched-out areas of decreased density predominating, two joints being slightly involved. In the hands the changes are nearly all arthritic changes, with slight involvement of the bones forming these joints.

Case 4. J.F.S. O.D.D. No. 36014. White, male, aged forty-two. Diagnosis: Gout, tophi.

ROENTGEN REPORT NO. 9216

Hands and wrists: There is a moderate degree of atrophy of the lower end of the radius, ulna, the bones of the carpus, metacarpals and phalanges of the left hand. There is a very slight amount of atrophy of the right carpus and the hand. The carpal joints appear normal. The inner margin of the base of the first phalanx of the right hand shows proliferative changes. The articular surfaces of the bones forming the right third metacarpo-phalangeal joint are in contact and their outlines are irregular. There are proliferative changes of the ends of both the bones of this joint. The middle finger of the right hand is a little shorter than the corresponding finger of the left hand. The other joints of the hands appear normal. In the head of the first metacarpal bone of the right hand is a small, oval area of decreased density. A similar area is present in the proliferative changes described in the base of the first phalanyx of the right index finger. On the dorsum of the right hand is a nodular area of thickening of the soft tissues above five centimeters in length.

Feet: All the bones of the tarsi, metatarsi and phalanges show a moderate amount of atrophy. All the tarsal bones show slight mottling. The bases of the third, fourth and fifth metatarsal bones of the right foot show mottling. The tarsal and tarso-metatarsal joints are for the most part not clearly defined in the plate, probably due to position. Those which are outlined appear normal. The terminal outer four phalangeal joints on each foot are distorted by position. The remaining joint spaces of the feet are normal in appearance. There are slight proliferative changes at the margins of the articular surfaces of the bones entering into the formation of the first metatarso-phalangeal joint of both feet. The inner portion of the head of each first metatarsal bone shows proliferative changes, is decreased in density and irregular in outline. The left great toe shows slight hallux valgus. The mesial outline of each first cuneiform bone is scalloped, due to notching with semicircular areas of decreased density. Similar changes are present on the mesial surfaces of the distal ends of the first phalanges of the halluces. In the proliferative changes described in the heads of the first metatarsal bones are small, more or less circular areas of decreased density. Two similar areas are found in the head of the fifth metatarsal bone of the left foot.

Summary of the radiographic findings: More or less generalized bony atrophy occurred. There was a small amount of proliferative changes. One joint space was obliterated with irregularity of the joint surfaces. Most of the joints appeared normal. Focal areas of decreased density were found. Modular thickening of the soft tissues were present.

Case 5. F. J. S. Med. No. 6154. White, male, aged forty-three. Diagnosis: Gout; tophi; obesity.

ROENTGEN REPORT NO. 9454

Hands and wrists: There are no bony changes.

Feet: There are slight proliferative changes of the margins of the articular surfaces of the bones forming the metatarso-phalangeal joints of both halluces. All other joints are normal. The head of the left first metatarsal bone shows a localized area of decreased density in its mesial portion. The area is figure 8 shaped. Its long diameter is 12 millimeters. Its borders are only fairly well defined. There is hallux valgus and pes equinus.

Summary of the radiographic findings: Slight proliferative changes affect the bones of the first metatarso-phalangeal joints. A focal area of decreased density is found in the head of the left first metatarsal bone.

Case 6. A. L. E. Med. No. 5297. White, male, aged forty-eight. Diagnosis: Gout; tophi; cirrhosis of the liver; questionable nephritis.

ROENTGEN REPORT NO. 1486

Hands and feet: The soft tissues present slight fusiform thickening with a tendency to be nodular in the fingers. Slight bone atrophy of all bones of the hands. The terminal joint space of the left little finger is narrowed, and proliferative changes are about the margins of the joint. The joint surfaces are irregular. Other joints of the fingers of both hands show narrowing of the joint spaces. Punched-out areas of decreased density are present in the head of the left ulna, carpal bones, and the left first metacarpal bone. The right ulna shows blunting of the styloid process.

Radiograms of the feet show bone atrophy of all the bones with diffuse mottling of the tarsal bones of both feet with slight proliferative changes. In the head of the right first metatarsal bone near the mesial margin a diffuse area of decreased density is present.

Summary of radiographic findings: The changes in the hands and feet show principally bone changes, with practically no arthritic changes.

Case 7. P. A. Med. No. 10814. White, male, aged forty-nine. X-ray No. 14570. Diagnosis: Gout; tophi.

Feet: There is slight narrowing of the metatarso-phalangeal joint of the right great toe. There are slight proliferative changes of the margins of the articular surface of the phalanx entering into this joint. There are proliferative changes of the margins of the articular surface of the phalanx entering into this joint. There are proliferative changes about a sesamoid bone just internal to the head of this metatarsal. All other bones and joints are normal. The head of the first metatarsal bone of the right foot on the mesial surface shows two small well-defined semicircular areas of decreased density about 3 mm. in diameter.

Summary of radiographic findings: There are slight proliferative changes and focal areas of decreased density in the head of the first metatarsal bone of the right foot.

Case 8. W. C. B. Med No. 10684. White, male, aged sixty-one. Diagnosis: Gout; tophi; chronic nephritis.

ROENTGEN REPORT NO. 14369

Feet: The heads of both first metatarsal bones and the first phalanx of the left hallux show small circular areas of bony absorption, from 1 to 2 mm. in diameter. The inner surface of the head of the left first metatarsal bone presents a mottled appearance. There is thickening of the soft tissues overlying the metatarso-phalangeal joint of the left foot. No joint changes are present.

Summary of radiographic findings: Focal areas of decreased density occur in the heads of the first metatarsal bones.

Case 9. A. S. Med. No. 10630. White,

female. Diagnosis: Gout; tophi; chronic nephritis; aortic insufficiency.

ROENTGEN REPORT NO. 14154

Hands and wrists: The bones of the hands and wrists are normal.

Feet: The bones of the ankle joints and of the tarsus are normal. The heads of both first metatarsal bones show small, fairly well defined, circular areas of decreased density. Otherwise there are no abnormal findings.

SUMMARY AND CONCLUSIONS

The soft tissues may or may not show nodular thickening of the soft tissues (tophi). These may be small or very large. The bones may show general bone atrophy, which process may be evenly distributed, or it may be irregular in its distribution. There is a marked tendency for the process to be symmetrical. In the arthritic variety the changes are both proliferative and destructive. The proliferative changes occur about the joints and along the shafts of the bones near the ends. They often appear as small knobs—exostoses (Bruce's nodes). Spur formation also occurs at the attachments of the tendons and ligaments. Destructive changes occur in the joints and are shown by narrowing and obliterating of the joint spaces and irregularity of the articulating surfaces. These joints resemble those seen in chronic infectious arthritis.

Another destructive process is the punched-out areas of decreased density. These are found in the heads of the first metatarsal bones, the bones of the wrist, the head of the ulna and radius, and in the bones of the phalanges. In the region of tophi the bones show proliferative changes and the punched-out areas of increased density, or there may be no visible change.

Radiograms of Cases 1, 2 and 3 are reproduced (Figs. 1-6), as they illustrate the different types of the processes shown in the series. It will be noted in Case 1 that the changes are practically all proliferative and that nearly all the joints are involved. There are very few of the punched-out areas of decreased density, the process being confined to the joints or their immediate vicinity. In Case 2 the changes are found principally in the bones themselves, the most prevalent change being the punched-out areas of decreased density, and the joints showing practically no changes except where in close proximity to the bone changes themselves. Case 3 is still another type and is a blending of the two previous types. The feet show principally punched-out areas, while the hands show arthritic changes and proliferation or exostoses about the shafts of the bones (Bruce's nodes). Case 1 is the only case that shows changes in the joints alone. Cases 2, 6, 7, 8, 9 show changes that are confined to the bones alone, the joints presenting practically no involvement. In cases 3, 4, 5 the joints and bones show changes. In case 4 the arthritic changes are confined to one joint in the hands while the bony changes are found in the feet.

For purposes of comparison radiograms of the hands and feet of 100 consecutive cases of non-gouty arthritis were studied. Among these 100 cases there occurred all the types of arthritis and also the punched-out areas of decreased density, similar to those which had been found in gout. The punched-out areas of decreased density were found in 13 of the non-gouty cases. From these findings it is evident that there are no radiographic findings in the hands and feet which are diagnostic of gout. But the types of arthritis described as occurring in gout and the punched-out areas of decreased density are changes very suggestive of gout.

The similarity between the bony changes found in the radiograms in gout and in the chronic non-gouty arthritides indicate the possibility of a relationship in the etiology of the two conditions. In this connection it is interesting to note that Magnus-Levy [5] states that a certain number of cases diagnosed as non-gouty arthritis are very probably actually gout. This conclusion was based on metabolic studies. Furthermore,

Nichols and Richardson[6] found sodium urate deposits on the articular surfaces of the bones of the knee joint in certain cases which were clinically arthritis deformans.

REFERENCES

1. HUBER. Ein Fall von Gichthand unter Roentgenbilde. *Deutsch. med. Wchnschr.*, 1896, 182, (12).
2. DRINBERG, E. Die Gicht in Roentgenbilde, Diss. Berlin, 1911.
3. STRANGEWAYS, T. S. P. A Study of Joints from Cases of Rheumatoid Arthritis and Chronic Gout by Means of Skiagrams, and Dissection of the Affected Parts; *Bull. Com. Study Spec. Dis.*, 1905-1910, i-iii, 87. A Study of Skiagrams from the Hands of 100 Cases of so-called Rheumatoid Arthritis and Chronic Gout, *ibid*, 145.
4. JACOBSOHN, E. Die Arthritis Urica im Roentgenbilde, *Mitt. a. d. Grenzgeb. d. Med. u. Chir.*, 1913, xxvi, 531.
5. MAGNUS-LEVY, A. Ueber Gicht. *Ztschr, f. klin. Med.*, 1889, xxxvi, 353.
6. NICHOLS, E. H. and RICHARDSON, F. L. Arthritis Deformans, *J. Med. Research*, 1909, xxi, 140.

DISC ATTACHMENT FOR VICTOR SERIAL TIMER

By HAROLD B. THOMPSON, M.D.

SEATTLE, WASHINGTON

THE accompanying photographs illustrate a simple disc attachment for the Victor serial timer to replace the various discs furnished with the timer, and by means of which a continuous exposure may be made, varying in duration from one-eighth second to ten seconds as desired. This is a great advantage over the interrupted exposure using the regular discs, when it would be necessary to allow more than five seconds to give an exposure of one and one-fourth seconds.

The device consists of a solid brass wheel of the same diameter as the wheels furnished with the timer. The periphery of this wheel is marked in ten equal segments, each being further divided into quarters, and one subdivided into sixteenths. One notch only is provided for breaking the circuit and this notch is insulated on all sides.

To use this device, the double-pole double throw switch (shown on the lawer part of the wall in Fig. 1) used for changing from the timer to the foot switch for fluoroscopy, is opened. The disc is then placed so that the end of the spring on the timer lever arm is opposite the number of seconds or fractions of seconds desired. The clock-work mechanism is then started. Closure of the double pole switch will now start the disc revolving and closing the x-ray circuit until the disc has revolved to the open notch, when it will automatically stop and the x-ray circuit be broken.

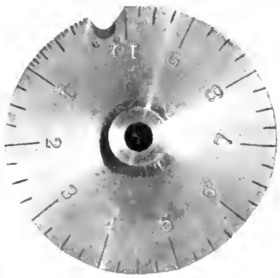


FIG. 1. SHOWS THE NEW DISC IN PLACE ON THE TIMER, REPLACING THE VARIOUSLY NOTCHED DISCS SHOWN ON THE CURVED RACK ABOVE THE TIMER. ALSO THE DOUBLE THROW SWITCH (lower part) WHICH CLOSES THE CIRCUIT THROUGH THE TIMER.

FIG. 2. VIEW (actual size) OF DISC ATTACHMENT.

The device has been found sufficiently accurate for all exposures down to one-fourth second. Shorter exposures are inaccurate on account of the variation in time of starting the disc to revolve by closing the timer circuit.

REPORT OF A CASE OF OSTEO-SARCOMA OF THE TIBIA

By CHARLES EASTMOND, M.D.

BROOKLYN, NEW YORK

The patient is a girl of sixteen who received a blow on the inner side of the leg just below the knee, in the latter part of January, 1920. The blow was produced by the spilling of a toboggan containing two other girls, and in the accident the side of the toboggan struck the leg.

Nothing but a slight degree of tenderness, pain and disability were experienced; but three weeks after the accident the patient went to the school infirmary where she remained in bed for three days. After this rest she felt sufficiently well to resume her studies. During Easter Week in spite of slight pain and disability she was able to ride in the Horse Show. In the early part of the first week of June the leg was roentgenologically examined and a diagnosis of osteomyelitis—possibly tubercular, was made.

She consulted Dr. J. C. Rushmore on June 5th, complaining of pain over the inner side of the knee with slight disability. The pain and disability had not increased markedly during the preceding few weeks.

She was seen by the writer on the same day, when the plates revealed a large area of destruction in the inner portion of the head of the tibia involving about one-half the diameter of the bone. Distinct tumor formation could be observed in the soft tissues to the inner side of the area of bone involvement, together with the presence of detritis and new bone formation. The joint surface was unaffected. A diagnosis of osteosarcoma was made. At the suggestion of Dr. Rushmore the films were submitted to Dr. F. H. Baetjer, who concurred in the diagnosis.

On June 9th an exploratory operation was performed for the purpose of determining the nature of the growth with the removal of a considerable section. The specimen was examined by Dr. Archibald Murray of Hoagland Laboratory, who made a diagnosis of spindle-cell fibro-sarcoma. The specimen was also examined by Dr. Jessup of New York, who confirmed the diagnosis. Amputation at the middle third of the thigh was performed on June 11th. Primary union of the stump occurred and the patient was on crutches on the fourteenth day.

COMMENT

This case is reported not because of its rarity but because of:

FIG. 1. OSTEO-SARCOMA OF HEAD OF TIBIA.

1. The difference of opinion on the two roentgenological examinations.
2. The marked rapidity of the growth.
3. Because of the thoroughness of the examinations, with checking up at every stage.
4. Because of the slight loss of time between the initial diagnosis and the completion of the case.

In the author's experience cases of this type do poorly and metastases develop at remote points with a fatal termination in a comparatively short time.

GLASS IN THE HAND

By A. R. TAFT, M. D.

CHARLESTON, SOUTH CAROLINA

A TOW-BOAT captain, twenty-eight years of age was referred for examination of the hand. While at sea, in attempting to close a window during a gale he cut his hand with broken glass. The wound under ordinary dressings healed by first intention, but he continued to have sufficient pain while using the hand and especially while flexing it, to make it necessary to use the other hand entirely.

When first seen here he had a scar about three centimeters long on the dorsal surface of the left hand between the thumb and the metacarpal of the first finger. Stereoscopic plates showed a foreign body, three cm. long and one cm. wide extending from the inner edge of the metacarpal bone of the thumb, dorsal surface, across the palmer surface of the metacarpal of the index finger to the inner edge of the metacarpal of the second finger.

There were also three small bodies situated in front of the outer end of this larger body. All of these, from the history and general density were taken, correctly, for glass.

Incision was made by Dr. Cathcart in the palmer surface over the superficial palmer area about 4 cm. long. Another horseshoe incision over the scar, and the pieces described were removed. The incision healed rapidly by first intention.

THE AMERICAN JOURNAL OF ROENTGENOLOGY

PUBLISHED BY PAUL B. HOEBER, NEW YORK CITY

Issued Monthly. Subscription, $6.00 per year. Advertising rates submitted on application. Editorial office, 480 Park Av., New York. Office of publication, 67-69 East 59th St., New York.

CORRESPONDENCE

MAYO CLINIC

ROCHESTER, MINNESOTA

DR. H. M. IMBODEN, *Editor*,
AMERICAN JOURNAL OF ROENTGENOLOGY,
480 Park Ave., New York City.

Dear Sir:

Enclosed please find a copy of the report of the Research Committee which was made at the meeting of the Radium Society in April at New Orleans. It is the desire of the Research Committee that an accurate and uniform record be kept of all cases treated with radium. In this way, uniform statistics may be collected, even though the treatment is given by many different individuals.

Very truly yours,
LEDA J. STACY.

SCHEDULE SUBMITTED BY RESEARCH COMMITTEE

1. Keeping records of all cases treated.
   1st page: Short history, diagnosis, grouping based on physical findings.

   2nd page:

Case No.	Date of Treatm.	Amt. of El. or Emanation Screening	Duration	Total mg. hours or mc. hours

2. Grouping of cases:
   A. Operable
   B. Borderline or doubtfully operable
   C. Inoperable
   D. Advanced and hopeless
   E. Recurrences—local, regional
3. Determination of E. S. D. of each tube of radium. The E. S. D. should be the standard of comparison of sensitiveness of the various elementary and diseased tissues.
4. The methods of screening and protection of healthy tissues surrounding—(a) distance; (b) material used.
5. The importance of postmortem examinations and serial sections of organs *in toto*, this being the only means to determine the correctness of the technic and the actual permeability of the rays, thereby establishing the actual therapeutic value of radium rays.
6. The re-examination of all patients at stated intervals and careful recording of subjective and physical findings at each examination (both visible and palpable).

TRANSLATIONS & ABSTRACTS

Honeij, James A., M.D. Cavity Formation and Annular Pleural Shadows in Pulmonary Tuberculosis. (*Arch. Int. Med.*, Vol. 25, No. 1, January 15, 1920.)

The signs of cavity in the lung, both on physical and roentgenologic examination, have always been a matter of interest and inquiry. The present paper aims to give added information on the subject, based partly on the examination and observation of a large number of cases in a tuberculosis hospital. Some years ago the author's attention was drawn to shadows in roentgenograms suggesting cavities, although no physical signs of cavity formation were present, and for a considerable length of time the failure to substantiate by roentgenologic means cavity signs obtained on physical examination has been noted. This inquiry covers cases with definite cavity formation and its classical signs, cases giving fair clinical evidence of cavity but not proven by roentgenologic methods, and cases giving certain roentgenologic images ranging from true cavity formation to a simple pleural thickening, without clinical evidence.

Roentgenographic Findings: These will be taken up in the following order: 1. Cavity. 2. True annular shadows. 3. Intrapulmonary annular shadows.

1. *Cavity:* The basis for the study of cavities from a roentgenographic point of view rests on postmortem findings and statistical data. The point regarding the pathology of cavitation emphasized in the first paper of this series applies, of course, here. Not all cavities are visible roentgenographically. Size by itself is not important; small cavities, 2 cm. in diameter, are frequently outlined more clearly, are more transparent and are more readily and correctly diagnosed than are larger cavities. It is, therefore, necessary that cavities, irrespective of size, be in such a position that the greater number of factors in diagnosis play a part. Cavities at the apex usually show more clearly than those at the base, provided the cavities which are compared are similar in size, type, and so forth. However, the fact must be borne in mind that there is a less depth to the lung at the apex, and less degree of congestion and secretion with gravity to play a part. Likewise, cavities occurring in or just outside the hilus area are more difficult to diagnose. This is largely because of the depth of the lung. In addition, the picture may be complicated by hilus shadows, congestion or fibrosis. Very often the cavity may be overshadowed, while occasionally a localized emphysema may be present. Provided other factors are taken into account, cavities which occur in the full pulmonary field are detected more readily than in those parts of the lungs where the shadows and outlines might be confused with them. Position, therefore, is of importance. The depth of the cavity—whether it occurs near or under the surface of the lung, or deep in the lung—is important. If situated deep in the lung, then the size of the cavity is undoubtedly an important factor; but the important point is the exact position and size of the cavity in the lung. The contrast between cavity and lung tissue must be noteworthy; that is the transparency in the area of cavitation must be greater than the normal transparency in that part of the lung, and, naturally, greater than that of the tissue surrounding it. It is, therefore, important that close attention be paid to the tissue changes surrounding an area of transparency. Usually, the greater the infiltration, or the more solid the lung, the greater the evidence that the area of transparency under observation, surrounded by this area of infiltration, is a cavity. From the roentgenographic point of view this infiltration will show as a more or less irregular heavy density greater than the usual mottling. If the density is more even and, perhaps, more opaque, then, in all probability, we are dealing with a pneumonia type of tuberculosis. It is obvious that in speaking of cavity he has in mind the result of necrosis and softening in an infiltrated area. Therefore, one should always bear in mind the pathology of different tuberculous processes when examining roentgenograms for possible cavitation. The duration of the disease indicates usually what may be expected besides the usual tuberculous changes; frequently repeated healing or breaking down may cause other tissue changes; fibrosis, for instance, or if the surface of the lung is involved, pleural changes and in consequence, extra shadows and increased density with numerous ouutlines. Under these additional conditions the transparency of the suspected area will be lessened and

its outline confused. The transparency of the cavity will vary just as much as the tissue density around it. This will depend (apart from the factors already mentioned) on the amount of air in the cavity. It must be in greater amount than the secretion or fluid present. The greater the amount of fluid present, the less likely will it be seen, and vice versa. If the cavity is large and the secretion abundant, change of position of the patient from the prone to the upright posture will bring about a change in density or of fluid level. The lower portion of the cavity will then be denser than the upper portion and the upper outline will be clearer. The transparency of the area and the surrounding tissue density also may vary from week to week, may vary with inspiration and expiration as seen under the fluoroscope, and will, of course, vary if acute conditions are superimposed which will produce congestion and, perhaps, added secretion. It is impossible to diagnose cavities when the density of the lung around the cavity (that is, back, front, or back and front of the cavity) is greater than the transparency. This is especially true if the cavity is small or filled with secretion. The outline of the cavities or areas suspected of being cavities is of diagnostic importance, but only after the above points have been considered. Cavities may have a clear cut, sharply demarcated outline, clearly differentiated from the surrounding tissue; or they may have an irregular, obscure outline that fades into the surrounding lung substance. The first condition usually indicates a fibrous wall; the second, cavity with continued destruction of lung tissue without definite walls or fibrous tissue outline. The first type of cavity is usually chronic, although the reaction of the lung tissue may be quite marked in acute self-limiting cases. In those cavities with a fibrous wall one can also invariably find shadows indicating fibrous tissue elsewhere in the lung. Under these circumstances one must particularly take into consideration the shadows produced by thickened pleura, the outline of which may be confused with the fibrous wall outline of a cavity or cavities. This is especially true if the outlines of several cavities are superimposed one on another. These cases are most often easy of diagnosis, provided one can definitely eliminate shadows produced by the pleura. The shape of cavities aids in the diagnosis. Circular or oval areas, even and regular in outline predominate in the majority of cases. A true cavity, especially one with fibrous wall, is seldom anything but oval or circular. In cases where cavity outlines are superimposed one over the other care should be taken that the resulting irregular outlines are not confused with the regular outline of a single cavity. Likewise, outlines of the rib, the border of the scapula or of the mediastinum, bronchial markings, or bands from a thickened pleura may be confused with the outline of the cavity. Lastly, the unilateral symmetry of the thorax must be taken into consideration, contraction of the rib spaces, the increased angle of the ribs themselves from the spine, and the narrow bony apical outline, as well as the total narrowness of the thorax; in short, any appearance of the thorax to indicate lack of respiratory effort or lack of lung function, and, therefore, immobilization of the chest wall, especially if in contrast to the opposite side. If there is cavitation at the apex, it is surprising to see the degree of contraction or collapse that takes place in the thorax wall from the apex to the third or fourth ribs. The physical findings should be included in all cases of cavitation, especially when the roentgenogram fails to give complete or definite evidence.

True Annular Shadows: These shadows are produced by the pleura. They have no relation to pulmonary infiltration or softening and breaking down of lung tissue. It is true that the two conditions may coexist, but it is equally true that pleural changes may be secondary to cavitation or vice versa. Consequently, if a case is presented in which cavitation is accompanied by a pleural annular shadow, it is generally impossible to differentiate the two conditions.

Intrapulmonary Annular Shadows: In a small percentage of cases these shadows occur in the full pulmonary field. Invariably, they are just outside the hilus area, one border of the ring shading off into the hilus itself. Although very rarely mistaken for cavities, these shadows may easily be confused with pleural annular shadows. Intrapulmonary annular shadows are rarely as regularly oval or circular as true annular shadows. Their walls commonly resemble perbronchial thickening and in the majority of cases a well defined communication is seen between the shadow and bronchi at the hilus or in the full pulmonary field. The inner border of the shadow does not differ

:rom the outer; both are slightly irregular or 'uzzy in outline. The transparency of the inner ırea is no greater than that of other portions ›f the lung. These shadows can invariably be liagnosed. If closely examined with the stereo-.cope, it will be found that the medial portion ›f the shadow, that is, the portion resting on he hilus, is heavier than the distal portion, ınd that it is definitely bronchial and hilic in ›rigin. The distal portion fades off, and ordi-ıarily the two points which form an arc or the ›uter half of the annular shadow, are sepa-·ated. The stereoscope definitely indicates that ntrapulmonary annular shadows are formed ›y two or more bronchial or root branches, and hat they are neither pleural nor cortical in ›rigin. These intrapulmonary shadows are .eldom seen either in the second or in the ad-'anced stage of tuberculosis. Indeed, if tuber-:ulosis is present to any marked degree, these ;hadows are made out with difficulty. They are lue to definite fibrous peribronchial changes ınd do not disappear. With the exception of ıiding in ruling out tuberculosis, clinical evi-lence seldom assists in the diagnosis.

SUMMARY

There are three conditions which at times nay be confused and which make a differ-:ntial diagnosis difficult or often impossible. These include (a) true cavitation in pulmo-ıary tuberculosis, with and without fibrous walls; (b) true pleural annular shadows, with ınd without pulmonary disease; (c) false an-ıular shadows of intrapulmonary bronchial ›rigin, occurring in early pulmonary tubercu-osis and other chest conditions. These three :onditions are illustrated here. He shows that ı clear understanding of the pathologic proc-:sses involved and thorough appreciation of the lifferent clinical signs are needed, and since, in ı broad sense, we are less interested in the ›resence or absence of cavitation than in its :ffect on diagnosis, treatment and prognosis, t is essential carefully to consider other acute ›r chronic lung lesions in conjunction with the lirect evidence of cavitation. Apical pleural ıdhesions are, of course, of much greater weight in the diagnosis of pulmonary lym-›hatic tuberculosis than are similar changes at he base. However, the mere presence of an ıpical annular shadow, although it may be due o the same process which occurs frequently ıt the base invariably leads to a more serious diagnosis than is warranted. If the movement of the lung at the apex were as great as at the base (all other conditions being equal), prob-ably fewer annular shadows would result from pleural thickening. If tuberculosis of the base of the lung occurred more frequently, we would be led, in a large number of cases, to a different diagnosis than that of mere pleural thickening. On the other hand, if every annular shadow depended on a cavitation in the lung, then the frequency of lung cavitation would be increased enormously. Under these circum-stances the presence or absence of preceding infiltration is unessential. In many cases dis-tinctly oval or circular areas of transparency which confuse the diagnosis are found. These areas, which are often outlined by bronchial shadows, bony structures or most frequently by the hilus, may be mistaken for cavitation, annular shadows or even bronchiectasis; oc-casionally they are produced by à localized emphysema. Finally, the physics of roentgen-ology and the limitations in roentgenologic di-agnosis must be remembered. If acute, con-gestive conditions prevail, it may be impossible to differentiate the lesions mentioned. Repeated roentgenological and physical examinations are, therefore, clearly indicated. The difficulty in determining the presence of a cavity can readily be imagined by a study of the path-ologic and roentgenologic findings in this con-dition. The roentgenologist errs more fre-quently in failing to diagnose a lesion when it is present than in diagnosing cavitation when it does not exist. Clinically, the reverse is true. A diagnosis of cavitation is frequently made when no cavity is present. This is no reflection on the clinician, for in both physical and roentgenologic diagnosis there are similar limitations.

W. W. Belden.

Iser, Solomon. The Roentgen Diagnosis of Subphrenic Abscess. (*Journal de radiol. et d' électrol.* Vol. 4, No. 2, February, 1920.)

The author presents the case of a man, aged fifty, with longstanding symptoms of pyloric stenosis. Cachectic condition, no fever. No other clinical findings were submitted to the roentgenologist. Fluoroscopic examination showed the presence of two large sacs filled with fluid; to the left the dilated stomach, to the right a collection of gas and fluid, clearly

subphrenic, which could only be a sub-diaphragmatic abscess. The stomach was immovable, and there was no peristalsis visible. During the entire examination no barium escaped from the stomach.

Pressure in the right hypochondrium was very painful. The long duration of the symptoms, the appearance of the stomach, and the fact that carcinoma is almost never complicated by subphrenic abscess led to the diagnosis of pyloric ulcer, and subphrenic abscess following perforation. Operation revealed a subphrenic abscess. The patient died, and autopsy disclosed the following: enormous, well encysted abscess, whose walls were formed by the convex surface of the liver, the stomach and the abdominal wall. Large perforated ulcer in the pyloric region, and a little higher up an ulcer perforating into the pancreas.

L. S. Goin, M.D.

Dandy, Walter E., M.D. Localization or Elimination of Cerebral Tumors by Ventriculography. *(Surg., Gynec. & Obst.,* Vol. XXX, No. 4, April, 1920.)

It seems incredible that a brain tumor as large as one's fist can exist in either cerebral hemisphere and still escape localization by expert neurologists and neurologic surgeons. Yet nearly all cerebral tumors eventually attain this size, and a very high percentage of them can neither be accurately localized before operation nor be found by an exploration of the brain. In a recent analysis of a series of 70 cases with neoplasm of the brain, Dr. Heuer and Dr. Dandy have shown that of forty-five cases which were presumably located in the cerebral hemispheres, twenty, or 44.4 per cent, escaped detection at operation; and at the time of that publication they considered this a high record in verifying the location of cerebral tumors. This percentage is not strictly correct, for several of the cases were submitted to more than one operation before the tumor was disclosed. On the other hand, in many cases which seemed to present definite signs of localization, the tumor could not be found because it was situated too deeply in the brain. A more careful analysis of these figures disclosed to an even greater extent the limitations of the neurological signs which are helpful in localizing brain tumors. Nearly all of the tumors which could be localized with certainty were in one of three locations, in each of which the signs are pathognomonic: (1) hypophyseal or third-ventricle tumors gave the characteristic disturbances of the optic tracts and destruction of the sella turcica; (2) precentral or postcentral lesions were evident by the contralateral motor or sensory disturbances; and (3) neoplasms affecting the motor or sensory speech centers produced the typical deficiencies of speech. The remaining cases which were localized exclusively by other methods, such as changes in the eye-grounds, disturbances of the other cranial nerves, etc., really comprised a very small group. There is only one satisfactory form of treatment for brain tumors, i.e., complete operative extirpation of the tumor. It is not conceivable that neoplasma of the brain ever disappear spontaneously or are cured or even benefited by any form of medical therapy. Nor, in our experience, has radium or the *x*-ray produced even temporary beneficial results.

Procedure for localization of the tumor by ventriculogography: Each lateral ventricle occupies a large area in the interior of either cerebral hemisphere. It is evident that a tumor of any size situated in either cerebral hemisphere will modify the shape, size, and position of the corresponding lateral ventricle. Quite frequently the lateral ventricle in the opposite hemisphere will be dislocated and its size also will be greatly modified. These changes in the ventricles, both homolateral and contralateral, yield many opportunities for locating brain tumors by ventriculography. Fortunately following the injection of air into one lateral ventricle, it is possible to obtain a roentgenogram of each lateral ventricle separately, and thus determine alterations produced by a tumor in either cerebral hemisphere. Owing to the angles of the ventricular system, it is possible to fill only one lateral ventricle with air when the head is in a given position. After a roentgenogram has been taken, the head must be carefully turned in such a manner that the air can pass the various ventricular angles and the interventricular foramina (of Monro) and the third ventricle, and thus reach the opposite lateral ventricle. After a lateral view of each ventricle has been photographed, the head should again be carefully turned in order to direct the air into the anterior horns of both lateral ventricles; the occiput will then be on the plate and the roentgenogram will give the

size, shape, and position of the anterior part of both lateral ventricles. Then by placing the forehead on the plate, the size and position of the body, and of the posterior and descending horns, can be demonstrated. It would seem that most tumors must give some manifestations of their presence in one of these views, and the findings must therefore absolutely indicate the position of the tumor. To introduce air into the ventricle of an adult, it is of course necessary to make an opening in the skull. This can be done either under local or general anesthesia, the choice largely depending upon the patient. Personally, I prefer local anesthesia with a responsive patient. The procedure need be but slightly painful and after transferring the patient to the x-ray room his coöperation eliminates respiratory movements and allows a much better exposure; moreover a considerable period of anesthesia is avoided during the time necessary to dress the wound and transfer the patient to the x-ray room. A ventriculogram will in many cases at once tell whether the tumor is cerebral or cerebrellar. In the latter cases an inter hydrocephalus will be evident by the symmetrically enlarged lateral ventricles. In some cases it will be found that the size of the ventricle has been so reduced that it is impossible to withdraw sufficient fluid to make the injection of air a safe procedure. It is then best to make a ventricular puncture on the opposite side and inject air into this ventricle, though occasionally both ventricles are too small. Not infrequently we can localize a tumor merely by the difference in the size of the two lateral ventricles as determined by the ventricular puncture or often by the abnormal position at which either ventricle may be reached. In a general way a very small ventricle is presumptive though of course not absolute evidence of a cerebral as against a cerebellar tumor or a tumor of the brain stem; when there is a difference in the size of the two lateral ventricles the tumor is usually on the side of the smallest ventricle. Even a bilateral ventricular puncture, which is only occasionally necessary is a small procedure compared to an exploratory craniotomy or even to a decompression, and the results obtained in localization of the growth not infrequently make the puncture far more valuable than an exploratory craniotomy. In infants and very young children, a puncture can be made through an open fontanelle or through sutures which have been separated by the abnormal pressure. During the past six months he has used ventriculography in over 75 cases from Professor Halsted's clinic. The majority of these cases had hydrocephalus; in many cases ventricular dilatation was suspected and the injection of air made the diagnosis certain. In many others the injection was made in order to determine whether the disease was progressive or stationary, in other words, as a means to determine whether or not operative treatment should be instituted. These cases will not be considered here but will appear in a subsequent paper. He describes here only the instances of tumors in the cerebral hemispheres or for very strong reasons suspected of being located there, and only those in which the ventriculogram has been the sole means of diagnosis. In many cases the localization of the growth has been easily determined by signs and symptoms and in such instances there is at present no purpose in instituting ventriculography, though he feels that eventually this method may be important in differentiating the type of tumor and determining the kind of operative treatment which is necessary. This possibility is strongly suggested by two of the cases described, but such a decisive stand in treatment, which in many cases might eliminate exploration of the tumor, will only be determined by an extensive experience in the interpretation of the x-ray findings in a large series of brain tumors. He describes five cases, each representing entirely different findings and showing the range of usefulness of this procedure when tumors of the cerebral hemisphere are suspected. Ventriculography will be seen to exclude a cerebral tumor when the lesion is situated elsewhere; precisely to locate the tumor when it exists in either cerebral hemisphere. In two of these cases there was no localizing sign by which the location of the tumors was even suspected. In both, the ventriculograms showed the precise location of the growth. In one case the tumor was entirely removed and the patient is now well; he had previously submitted to two exploratory craniotomies but the tumor could not be found. In the second case a decompression had been done; after localization of the tumor by a ventriculogram, a very large infiltrating glioma was found at operation but could not be removed. The patient was spared further useless operations by the ventriculographic localiza-

tion of the tumor. In a third case the signs were differently interpreted; a large localized bulging in the right temple seemed to indicate an underlying tumor. There was a complete sensory and motor paralysis of the trigeminal nerve which could have resulted from pressure on the gasserian ganglion; or the paralysis might have been due to involvement of the trigeminal root in the posterior cranial fossa. The ventriculogram conclusively determined the location. In a fourth case, an exploratory craniotomy in a case of focal epilepsy disclosed a greatly dilated ventricle—apparently hydrocephalus; subsequently the ventricles were injected with air and the ventricular dilatation was found to be unilateral—a very rare condition. A fifth case can hardly be included as a result following ventriculography for air could not be injected, but the attempt at the procedure was responsible for locating the tumor. The ventricle was found by a ventricular puncture to be markedly dislocated to the left, but it was so small that only a few drops of fluid could be obtained from the needle. Under such conditions it is not safe to inject air. The dislocated position of the ventricle could only be caused by a tumor in the opposite side of the brain. The extremely small size of the ventricle must be due to the intracranial pressure produced by the tumor. The neoplasm was found in the right prefrontal region and completely removed.

CONCLUSIONS:

1. Ventriculography is invaluable in the localization of obscure brain tumors. So-called unlocalizable tumors comprise at present over half of the total number.

2. Practically all brain tumors either directly or indirectly affect some part of the ventricular system.

3. Hydrocephalus is easily demonstrable by ventriculography and when present usually though not always restricts the location of the tumor to the posterior cranial fossa—that is, the brain stem or the cerebellum.

4. Local changes in the size, shape, and position of one or both ventricles as shown by the ventriculogram will accurately localize most obscure tumors of either cerebral hemisphere.

5. Every effort should be made to localize the tumors before resorting to any operative procedure.

6. The usual subtemporal decompression is useless and dangerous when a hydrocephalus is present, that is when the tumor is in the brain stem or cerebellum.

7. A suboccipital decompression (cerebellar operation) is extremely dangerous when the lesion is in the cerebral hemispheres.

8. To differentiate between cerebral and cerebellar lesions is frequently one of the most difficult tasks in intracranial localization. Ventriculography at once separates these two groups and indicates the operation of choice.

9. The only cure for brain tumor is extirpation. The results in terms of complete cures of brain tumors will be in proportion to the early localizations which are made. A decompression is a purely palliative procedure and should be adopted only when the tumor cannot be located. Ventriculography permits of an early and accurate localization of the growth when all other methods fail.

10. It is possible to get a separate profile ventriculogram of the whole of each lateral ventricle. Any change in size or contour is easily demonstrated. Anteroposterior views will show the same points in cross section but they are chiefly useful in showing any lateral dislocation of the ventricles.

11. The results in localization of five types of cases of brain tumor are shown with ventriculograms. In all but one of these, the ventriculogram was the only means by which a positive localization could be made. One tumor occluded a lateral ventricle and dislocated both lateral ventricles. Another tumor altered the size and shape of one lateral ventricle. In a third case a cerebral tumor, though suspected, was eliminated by the hydrocephalus. In a fourth case a unilateral hydrocephalus was demonstrated.

12. Occasionally the size of both ventricles is so reduced that air cannot be safely injected. In one case the dislocated position of both ventricles, which were greatly reduced in size, made the localization possible.

13. Ventriculography is also useful in precisely localizing the growth. This permits of an exploration directly over the tumor and greatly simplifies the operative procedures.

14. Many usleess and harmful operations will be spared the patient by a judicious use of ventriculography.

15. Doubtless the type of tumor will often be indicated by the ventriculogram. Such knowledge will be useful in prognosis and in

determining whether radical or palliative operative treatment should be instituted. These determinations will result from accumulated experience in the interpretation of the ventriculograms together with the correlative operative findings presented in a large series of cases.

16. With experience and care in the use of ventriculography, I believe few tumors will escape accurate localization.

W. W. Belden.

Frank, Louis, M.D., Louisville, Ky. Congenital Diaphragmatic Hernia. (*Ann. Surg.*, Vol. LXXI, No. 3.)

Scudder, in 1912, could find only fifty-three cases of diaphragmatic hernia which had been subjected to operation. Since then a number of cases have been recorded. They, however, conclude that those of congenital origin are exceedingly rare and do not often come to operation. More rare, for evident reasons, are those, whether congenital or traumatic, occurring on the right side.

Of the additional cases recorded in the literature only five were reported as congenital, those observed and operated upon being accounted for largely by the trauma of war. Most of the cases occurred in soldiers as the direct result of missiles. In this type of cases, also, it is a fact, explained by the anatomic position of the liver, that the hernia was almost uniformly upon the left side.

In the description of diaphragmatic hernia there is nothing to surpass—either from an anatomic standpoint, or from close study and analysis of the symptomatology in both strangulated and non-strangulated cases — that written by Cooper in his classical work on hernia published in 1804. He divides diaphragmatic hernia into three varieties, and it is believed his division holds good today. He first classifies them into congenital and acquired. Under the congenital type he describes two varieties, one in which there is a distinct peritoneal sac, in the other there being no sac. The third variety also has no sac, this being entirely traumatic in origin.

A study of the literature confirms Cooper's opinion that congenital herniae of the second variety are rarely seen, as the subjects usually die at birth or shortly afterward. In the first variety of the congenital type the individual may live for quite a period of years, and in his work Cooper mentions such cases, describing also cases of the second variety and of the traumatic type.

Beckman believed that the congenital type could not be benefited by operation, and the opinion was then expressed repeatedly and set forth in text-books on surgery that such herniae should not be operated upon unless they become strangulated, and this seems to have been the general practice. Beckman says the congenital type are not true herniae in that they have no sac. In the face of the reported cases, which have been carefully studied, this contention can hardly be maintained.

Giffin, in 1912, and Scudder in the same year reviewed most carefully and completely all the literature of this subject. At that time about one thousand cases had been recorded, though of these a very large proportion had been discovered only at autopsy. Scudder's study showed that there had been about fifty-three operations performed for diaphragmatic hernia at that time, and of this number thirty-nine patients had died. The thoracic approach was used in eleven, of which seven recovered; the abdominal approach in forty-two, of which thirty-five died. In these fifty-three cases deliberate operations based upon pre-operative diagnosis was performed in only six, the other patients applied to the surgeon for relief of intestinal obstruction; and, as he says, this is most likely the cause of the high mortality.

Recently, as has already been said, probably as a result of war wounds, the subject has again been brought to the attention of the profession particularly by Soresi, in a paper published during the current year. He reports one congenital and two traumatic cases, suggesting a method of closure to insure against recurrence of the hernia. We may say, in passing, that we know from experience it is not always possible to successfully execute a previously planned procedure for permanent cure in these cases. This is also well illustrated by Downes' case of congenital hernia in a boy about seven years of age, where it was impossible to restore the viscera to the abdominal cavity, necessitating, on account of the extreme condition of the child, a gastro-enterostomy to prevent starvation.

Downes believes from his experience that the abdominal approach is better, because in congenital cases where hernia has occurred

through a dilated opening it may be impossible to correct the condition by approach from above. In their own case, it was impossible to deal successfully with the condition through the abdominal incision, necessitating a transthoracic operation.

Attention is called by the author last quoted to the possibility of mistaking a full stomach herniated through the diaphragm for pyopneumothorax, and he states that several cases have been recorded in which such a mistake, followed by aspiration, terminated fatally. While in former years there may have been difficulty in diagnosis, it is believed today that with the aid of the roentgenologist and stereoscopic views, the diagnosis can be accurately made in practically every case. In their own case no difficulties were presented after a stereoscopic picture was obtained.

Where a large portion of the stomach is herniated, the clinical history is similar to that of hour-glass or obstructed stomach, except that there are periods of remission and the symptoms begin in early childhood. However, the symptomatology, pathology, and etiologic factors have been so fully discussed in the literature that they are not considered further in this paper, the desire being rather to report an interesting and probably unusual case, with the difficulties encountered in efforts at relief.

W. W. Belden.

Lagarenne and Guilleminot. Pharyngo-Esophageal Diverticula, or Pulsion, Diverticula of Zeuker. (*J. de radiol. et d' électrol.* Vol. 4, No. 2, February, 1920.)

The authors review the literature, and present a case of their own. These diverticula occur entirely, or nearly so, at the pharyngo-esophageal junction, which is normally at the lower border of the cricoid cartilage. Following Mayo, Guisez and others they insist that they must be called pharyngo-esophageal diverticula, rather than esophageal. They arise just above the pharyngo-esophageal junction, and are posterior. The mechanism of their formation is as follows: Arising from the cricoïd cartilage are the fibers of the crico-pharyngeal muscle. Passing backward, they divide into two bundles; the superior, which terminated in the mid-line, and the transverse, forming a semilunar fold at the superior orifice of the esophagus. It is between these two bundles that the diverticula occurs. The exciting cause is an inflammation, from caustics, etc. The retching, attempts at swallowing, pressure of ingested food, etc., little by little push the mucosa between the muscle fibers, and the diverticulum is formed. The diagnosis is easily made by fluoroscopy. The treatment is surgical, and consists in extirpation of the pouch.

L. S. Goin, M.D.

THE AMERICAN JOURNAL OF ROENTGENOLOGY

Editor, H. M. Imboden, M.D., New York

ɔL. VII (NEW SERIES) OCTOBER, 1920 No. 10

ɴSTANTANEOUS RADIOGRAPHS OF THE HUMAN HEART AT DETERMINED POINTS IN THE CARDIAC CIRCLE

By J. A. E. EYSTER, M.D., and WALTER J. MEEK, Ph.D.

Physiological Laboratory, University of Wisconsin

MADISON, WISCONSIN

INTRODUCTION

MPROVEMENTS in x-ray apparatus, allowing more rapid exposures to be ıde, and the development of methods for ıking accurate determinations of cardiac ɛa and volume, open up interesting and portant fields for study in reference to rdiac movements, and determinations of ɛ extent and character of contraction. .rdeen [1] has shown by patient and thor- gh researches that it is possible to deter- ne the diastolic volume of the heart from ɛ x-ray shadow area with an error of less ın 10 per cent. The determination of the ıstolic size and shape offers no serious ɔhnical difficulties, because it is the phase the heartbeat which gives the greatest ıdow, and the exposure may be prolonged include several cardiac cycles. Determina- ɔn of the area of the shadow and volume the heart in phases of the cycle other than ıstole offers two considerable technical ficulties; first, the exposure must be suf- iently short to include only the particular ase desired, and second, there must be me means of determining accurately the rticular phase of the cycle in which the exposure is made. It is the purpose of this paper to describe a method by means of which these difficulties have been overcome, and to give briefly some of the results which have been obtained by its use.

METHODS

Efforts to obtain satisfactory x-ray shadowgraphs of the heart sufficiently rapid to include only a single phase of the cardiac cycle, and sufficiently distant from target to film to prevent undue distortion, were made by one of the present authors in collaboration with Dr. Dardeen in 1917. At this time we succeeded in obtaining satisfactory results with the full output of a 10 K.W. transformer, with a working distance of two meters, and an exposure of approximately one-twentieth of a second, using a gas tube selected from a considerable number at our disposal. The method of determining the phase of the cycle in which the exposure was made was a modification of that employed by Huismans,[2] in which a tracing of the carotid pulse was made and the instant of discharge of the transformer marked on this tracing by an electromagnetic signal. In order to obtain

an exposure at a determined point in the cardiac cycle, the carotid tambour made an electrical contact at a fixed period in its excursion. A subsequent exposure was usually made on the same film by a second closure of the current through the transformer by means of a key which was closed by a falling body. The falling body was released by the first exposure, and the period from the first to the second closure could be timed by varying the distance through which the body had to fall before closing the second contact. This method was used in estimating cardiac output in man by determining the area of the systolic and diastolic shadows, and calculating the difference in the volume of the heart at these two phases. A brief discussion of this method with a statement of results is given in Dr. Bardeen's [3] paper. We have abandoned this method for the following reasons: (1) the great difficulty of maintaining a gas tube in the proper condition for rapid exposure; (2) the inaccuracy of utilizing the carotid pulse as a means for determining the incidence of exposure in the cardiac cycle, and (3) the difficulty of accurately following two outlines of the heart when superposed on the same film. The impulse in the carotid artery occurs an appreciable period of time after the beginning of cardiac systole, a period combining that of rising tension in the ventricle (presphygmic period), and in addition the time of transmission of the aerial wave from the base of the aorta to the artery in the neck. Both of these factors show slight variation in the same and may differ markedly in different individuals, and are difficult to estimate accurately.

The method that we are at present using provides for the accurate determination of the incidence of exposure by recording a simultaneous electrocardiogram. The work of a number of investigators [4] has shown that the electrocardiogram is an accurate index of the onset and duration of ventricular systole. The onset of the R complex of this curve precedes ventricular systole, as measured by the initial rise of intraventricular pressure, by a few hundredths of a second, and is practically coincident with the beginning of the first heart sound. The end of the T wave likewise indicates the end of ventricular systole as marked by the closure of the semilunar valves and the occurrence of the second heart sound. The end of the T wave of the electrocardiogram coincides with the onset of the second heart sound with a plus or minus variation of approximately one-hundredth of a second. The determination of the incidence of exposure by the electrocardiogram has two great advantages over other methods; first, that the two most important events of the cycle, the beginning and end of ventricular systole, are sharply indicated, and second, that inertia or lag in the instrumental recording is negligible. An electrocardiogram is made by the usual method, connections being made with the subject by electrodes on the right wrist and left ankle. The galvanometer and the x-ray apparatus are in different rooms and connection is made by wire in conduit. The leads from the galvanometer come into the x-ray room at right angles to the aerial wires in order to reduce induction. The onset and duration of the discharge of the transformer in making the x-ray exposures is marked on the galvanometer record by a series of vibrations (Fig. 2) resulting from induction between the aerial wires and the wires leading from the subject to the galvanometer. The amount of this induction can be varied by varying the position of the wires until there is sufficient to record, but not enough to throw the galvanometer thread out of the field. A telephone connection between the x-ray and electrocardiographic laboratories made coordinated operation possible.

A regular Coolidge 10 milliampere radiator tube is now being used for all exposures and this receives the full output from an eight kilowatt "Standard" transformer. With a filament current of 4.8 amperes there is a spark gap of about seven inches. We have made no attempt to measure the milliampere discharge. The distance from the target to plate is one meter, the period of

exposure about one twenty-fifth (0.4) seconds. Distortion of the shadow area is corrected by measuring the distance from the film to the target and estimating the distance from the heart by measuring the antero-posterior diameter of the chest and taking one-third of the distance from the anterior surface. The anterior surface of the chest is brought as closely as possible to the film.

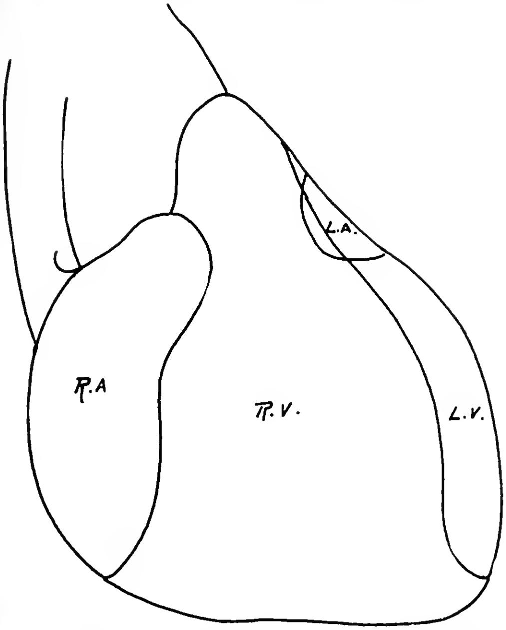


Fig. 1. Outlines of Chambers in Human Ventricle. Anterior aspect.

Duplitized films are used between two reinforcing screens. The exposures are timed either by circuit breakers or fuses. Circuit breakers will work as low as one-fiftieth second, and at any setting are accurate in their timing of successive exposures, as we have found by repeated measurement of the duration of discharge of tubes by a moving film and tuning fork. Exposures as timed by fuses are much less constant. With a primary current of 220 volts and 50 amperes, a 6 ampere fuse will break on an average in about one-twentieth of a second, but there is considerable variation.

In order to obtain exposures on different films within the same heart cycle, we have devised a casette-changing mechanism allowing of two exposures within a period of eight hundredths of a second. One casette is in a carriage attached to heavy springs and is held in place in the field of exposure by a catch. The other casette is immediately in the rear of this and is pressed against it by the spring, a lead plate intervening to prevent exposure of the film in this casette during the first flash. The first closure of the primary circuit through the transformer makes the exposure of the first film, which is terminated in approximately one twenty-fifth of a second by the release of the circuit breaker. The movement of the solenoid arm of the circuit breaker also releases the carriage to which the first cassette is attached, and this is suddenly jerked out of the field, the second casette at the same time moving forward into the field to take its place. As the carriage containing the first casette moves out of the field of exposure, it closes an electrical switch which connects a second circuit through the primary containing either a second circuit breaker or a fuse, and the exposure of the second film results. The whole apparatus is attached to a heavy steel frame which prevents vibration.

For the placing of exposures at desired points in the heart cycle, the method we have adopted after trial of several is simple manual closure of a key while listening to the heart sounds through a stethescope. The two principal heart sounds mark important events in the cardiac cycle. The first begins at the onset of ventricular systole when the ventricle begins to contract down upon its full complement of blood. This phase of the cycle, usually designated as the period of rising tension, or presphygmic period, continues for approximately seven hundredths of a second in the human heart, and during this time the heart volume remains unchanged and represents the full diastolic size of the heart. The beginning of the second sound represents the end of the period of outflow or emptying of the ventricle, and the heart again retains the same volume for approximately the same length of time as following the first sound, and this period, the postsphygmic, represents its smallest or sys-

tolic volume. Two exposures made in the same cycle, one coincident with the onset of the first, and the second coincident with the onset of the second sound, give a basis for the determination of the volume of the heart when it contains the greatest and the least amount of blood, and the difference between these must be the volume of blood pumped at that beat. This figure, multipled by the number of beats per minute, represents the minute volume output of the two ventricles.

With a regular heart rhythm, it is surprisingly easy to make the two exposures at the time of the two heart sounds by simple manual closure of a key while listening to the sounds. It is also possible voluntarily to delay closure and have the exposure come at other times, the incidence in every case being marked by the simultaneous electrocardiographic record. One gets the "swing" of the rhythm while listening and the key closure becomes a matter of anticipation and not of reaction. We have also worked with a sound amplifying device which closes the primary of the x-ray transformer automatically with each heart sound, but up to the present time we prefer the manual method because of its simplicity and selectivity.

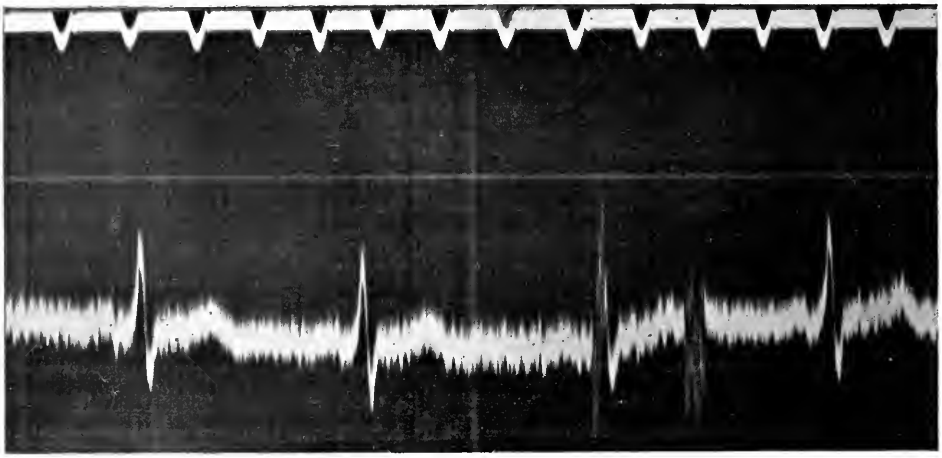


FIG. 2. ELECTROCARDIAGRAM FROM LEAD II, SHOWING INCIDENT OF X-RAY EXPOSURES.

RESULTS

The data that we have obtained up to the present time by the use of this method is associated with several lines of study. We wish to report at the present time only certain observations concerning the change in size and shape of the normal human heart during the several phases of its cycle, reserving for subsequent communications observations of the cardiac volume output in man and experimental animals under normal and pathological conditions. The parts making up the outline of the x-ray shadowgraphs of the human heart are shown in Fig. 1. It is seen that this outline is made up by all the chambers of the heart, the left auricle however being included only to a very limited extent.

Studies of the change in the shape of the human heart during the various phases of the cardiac cycle have been made in ten young adults with normal hearts. In all of these, systolic and diastolic exposures were made in the same cycle. Other sets of two exposures were also made at other times in the cycle within short periods and under similar conditions. All exposures were made during the phase of normal inspiration, and in the standing position.

In Fig. 2 is shown an electrocardiagram from one of the subjects showing two discharges of the x-ray transformer, one occurring within the R complex and hence occurring during the presphygmic period of the ventricle, the other at the end of the T wave and hence at the end of ventricular systole.

In Figs. 3 and 4 the radiographs from these discharges are reproduced and these are superposed in Fig. 5 to bring out the difference in the borders of the heart. Superposition may be accurately made with the rib outlines and the outlines of the aluminum capsule which replaces the usual stethescope bell and which may be seen projecting from the left of each figure.

In Figs. 6 and 7 the outlines of two hearts in different phases of the cycle are shown. The radiographs were made as described above and the outlines transferred to a single diagram. The position of the individual exposures, as determined from the electrocardiographic records, are indicated on the diagrammatic electrocardiogram. In Fig. 6 the first exposure was made at the end of systole of the ventricles, the second in mid-cardiogram. In Fig. 7 the first exposure was diastole, and the third immediately before contraction of the auricle as indicated by the auricular wave ("P" wave) of the electrocardiogram. In Fig. 7 the first exposure was made immediately before auricular contraction, the second during the presphygmic period of the ventricle, the third near the middle of the period of ventricular outflow, the fourth at the end of the period of ventricular outflow, and the fifth in mid-diastole.

The observations that we have made up to the present time on the normal human heart enable us to make certain statements as to the normal movements of the human heart.

Fig. 3. Radiograph of Human Heart During Full Diastole.

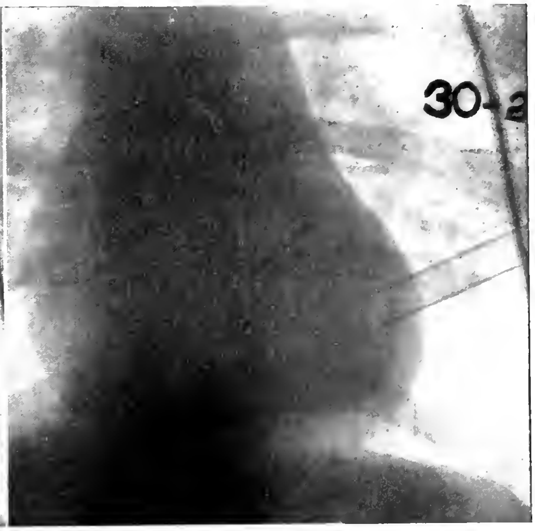


Fig. 4. Radiograph of Same Heart Shown in Figure 3 During Height of Systole.

The decrease in size of the cardiac area during systole may involve any of the outlines, but does not usually involve all. The

Fig. 5. Superposition of Figures 3 and 4, Showing Change in Size and Outline of Heart as a Result of Contraction.

outline corresponding to that of the right auricle varies least in position, while the left

ventricular outline, particularly toward the apex, is the margin which undergoes as a rule the greatest movement. The border of the right ventricle nearly always shows a definite ascent, and there is usually, but by no means always, a descent of the base.

The rule seems to be a slight increase in the right auricle outline during systole, due to the collection of blood in this chamber at this time; but this is not invariable, and the border may actually reduce during systole. The same heart may behave differently at different times, at times reducing certain borders, at other times other borders. If one compares the actual shape and sizes of the diastolic shadows, they agree closely, and this is also true of the systolic shadows. It would seem, therefore, that the differences noted may be due to slight changes in position of the whole heart rather than to differences in character of contraction.

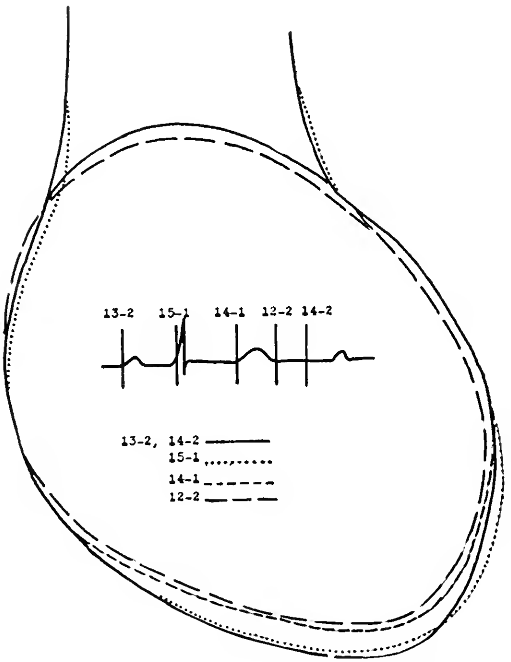


Fig. 6. Changes in Outline of Human Heart During Contraction.

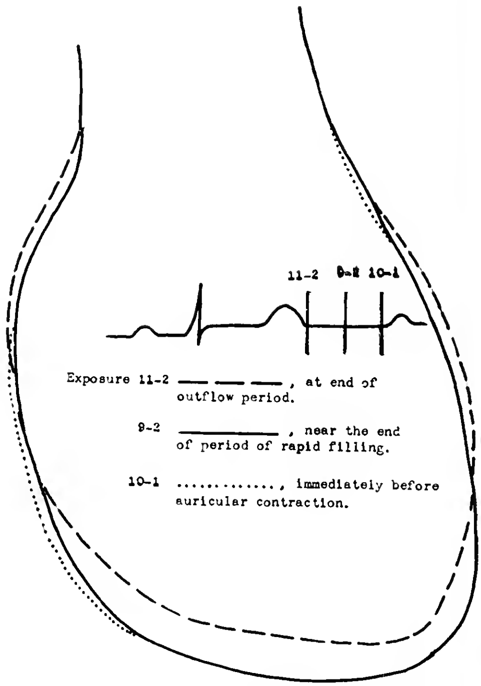


Fig. 7. Filling Period of Human Ventricles. The three x-ray exposures were made as shown by electrocardiograph record.

The part of the left ventricular border affected may likewise vary. Usually the maximum change is at or near the apex and decreases upward, but the reverse may be seen. The movement of any one point on the left border may give an entirely erroneous idea as to the extent of contraction of the heart. The change in the greatest transverse diameter may therefore give little accurate indication of the extent of contraction. What may be regarded as a typical cardiac contraction may be described as follows: When the auricles contract, the right auricular border decreases slightly, and there is a corresponding enlargement showing along the lower border of the left ventricle and right ventricle. The apex moves about 1 mm. to the left and the heart becomes slightly more elongated from base to apex. How much effect the auricular systole has in adding blood to the ventricular complement is impossible at present to say, but it is certainly very small, and in many instances cannot be made out. As the ventricles contract, the right auricular border enlarges slightly and extends outwards slightly more than immediately before auricular systole. The bases

of the ventricles descend a few millimeters and the whole heart shadow becomes more globular in outline. The apex moves upward and to the right, the right ventricular border moves towards the base and the left ventricular border to the right. Succeeding the period of outflow the ventricles fill, and this filling appears to be somewhat more rapid early in diastole than later. Thus in a comparison of the full diastolic shadow in one case with the shadow 0.05 sec. after diastole begins there was a difference in volume of 32 c.c. The normal difference in diastolic and systolic volume in this heart was 42 c.c., and the total period of diastole about 40 sec. Thus about one fourth of the blood has entered in the first one eighth of the diastolic period. In another determination 26 or 83 c.c. of blood or about one third had entered in the first one fourth of the diastolic period. In another case with a slow heart (pulse of 60) and a large output per beat (107 c.c. average of two determinations), nearly half of the filling occurred by the end of the first one seventh of the diastolic period. The major part of ventricular filling seems to occur therefore almost as rapidly as the emptying. In one determination a systolic shadow (No. 39) made 0.10 sec. after the beginning of systole differed by only 6 c.c. in volume from a similar shadow 0.10 sec. after the beginning of diastole. In this case the systole had a duration of 0.27 sec. diastole 0.38. The normal output per beat was 46 c.c.

SUMMARY AND CONCLUSIONS

A method is described for making rapid x-ray shadowgraphs of the human heart with a casette-changing mechanism allowing two exposures within the same cardiac cycle.

By recording a simultaneous electrocardiogram the exact incidence of these exposures in the cardiac cycle is determined, and their position may be quite accurately chosen by listening to the heart sounds and closing a key by hand.

The changes in shape and size of the normal human heart during its cycle are described so far as we feel justified on the basis of observations made up to the present time. The most important points that we feel are evident at present are the following:

1. The movement of no single border of the heart is an accurate index of the extent of its contraction. The whole outline is necessary for such estimation.

2. The mechanism of ventricular filling would seem to be very similar to that which physiological experimentation has constituted in the dog,[5] especially in that the major part of ventricular filling occurs shortly after the ventricle goes into relaxation and is in large part completed before the subsequent auricular contraction, systole of this chamber playing little rôle in adding blood to the ventricles.

REFERENCES

1. *Am. J. Anat.*, 1918, xxiii, 423.
2. *Verhandlungen der Kongress für innere Medizin*, 1914, xxxi, 435.
3. *Loc. cit.*
4. KAHN. *Arch f. d. ges. Physiol.*, 1910, cxxxii, 209. HOFFMANN and SELENIN. *Ibid*, 1912, cxlvi, 305, and others.
5. HENDERSON. *Am. J. Physiol.*, 1906, xvi, 325.

CARDIOSPASM

By P. F. BUTLER, M.D.

Assistant Roentgenologist, Boston City Hospital

BOSTON, MASSACHUSETTS

THE study of spasm of the cardiac end of the stomach and its later development, cardiospasm, does not receive the attention that this distressing condition warrants. Spasm of cardia is not as rare as generally believed; it can be demonstrated in many of the cases where a lesion of the upper stomach is present. True cardiospasm, however, is not a common condition. Most of the literature refers to one or two cases observed by different men. Smithies, however, reported sixty-three cases in seven years, in a very thorough paper.[1]

Spasm of the cardia is secondary to an organic lesion, and the latter may be in the esophagus, stomach, duodenum, gall-bladder, appendix or pelvis. I have followed two well marked cases and seen them cleared up for two years—as long as they could be followed—by the removal in each case of a chronic appendix.

If spasm of the cardia persists long enough it results in first a temporary and later a permanent obstruction. The latter condition is accompanied by hypertrophy of the cardiac sphincter and the lower portion of the esophageal musculature, diffuse dilatation of the esophagus, kinking and tortuosity of the esophagus and later by obstruction. There may be great dilatation and retention of four or five meals without visible pressure symptoms on the other thoracic viscera, because the slow development gives time for the process of accommodation. The onset is most often gradual and the condition usually is present for two or three years before complaint is made. It is most often found in early adult life, and in males slightly more often than in females. It may also be congenital or at least occur very early in life. Stenosis may result from persistent spasm over a period of years, followed by its accompanying sequelae, malnutrition, constipation, dizziness, anemia and eventually death.

The clinical picture of cardiospasm reveals absence of pain, difficulty in swallowing (more marked with liquids), early sense of fullness while eating or drinking, copious regurgitation (often propulsive), loss of weight (from starvation), and constipation (from lack of fluids). There is never the picture seen in carcinoma, of toxemia from absorption. The vomitus shows undigested food, no blood or gastric elements, long retained food.

Roentgen examination gives a typical picture; dilated esophagus, perfectly smooth in contour, coming down to a point at its lower end and long retained barium. In carcinoma there is little dilatation above the obstruction because of the rigid, infiltrated walls, and the outline at the constriction is ragged; in addition the carcinomatous obstruction passes only fluids, while the cardiospasm takes solids better. The spasm may be intensified by the use of irritating substances, as ground pineapple, or by very cold drinks, and may often be relieved by atropine. Stricture following trauma (foreign bodies, caustics, etc.) rarely is seen so low down, and furthermore has a definite history. Syphilis, of course, may imitate every condition, but is very rare in this location and also offers other positive diagnostic evidences.

The case presented is one of congenital cardiospasm in a man of thirty-four; he has had difficulty in swallowing as far back as he can recall. He was admitted to the service of Dr. Libby of the Boston City Hospital for pneumonia and passed successfully through it. During convalescence he was examined in the roentgen laboratory, and ordinary chest plates were made, which revealed the condition seen in Fig. 1. A fluoroscopic examination was made the follow-

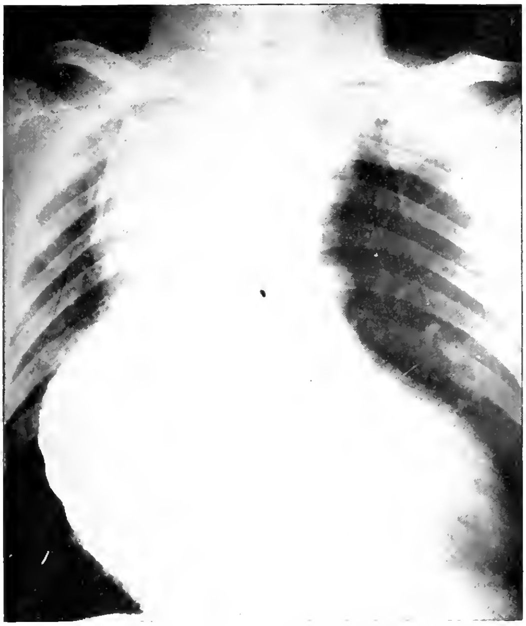


FIG. 1.

FIG. 3.

FIG. 2.

ing day to investigate the unusual appearances seen on the plates. The heart was normal in size and not displaced. The excursions of the diaphragm were normal on both sides. There was no pulsation in the tumor-like masses in the upper and lower chest. A swallow of barium was given and with much difficulty was followed on a tortuous, wandering path down to the cardia; it first disclosed a fluid level in the third interspace, after which it went off to the right, then straight backward, then to the left and next downward and forward to the level of diaphragm, sometimes through the center of the opaque area and sometimes along its sides. More barium was then given and it soon became apparent that we were dealing with a greatly dilated esophagus partially filled with food and liquids.

About this time the patient regurgitated about a quart of fluid and immediately more barium mixture was given; this filled the canal quite thoroughly and the plates shown in Figs. 2 and 3 were taken. Three pints of the mixture were given, with no apparent distress. Twenty-four hours later there still remained about an ounce of barium mixture in the lower esophagus, the remainder having passed on to the large bowel. At a second examination, after the patient had fasted for about ten hours, the esophagus had diminished considerably in size and

showed a fluid level at the junction of its lower and middle thirds. The measurements at this time were 6 cm. on a level with the arch of aorta, 5½ cm. in its middle third and 6½ cm., about two inches, above the diaphragm, from where it narrowed down toward the cardia. This man, by the way, was well developed and showed no ill effects from the lesion.

1. Smithies, F., *J. Roentgenol.*, 1919, ii.

CASE OF XANTHOMA SHOWING MULTIPLE BONE LESIONS

By A. S. MERRILL, M.D.

Assistant Roentgenologist, Massachusetts General Hospital

BOSTON, MASSACHUSETTS

This rare disease was first described by Addison and Gull in Guy's Hospital Reports of 1851. After many years' careful study the etiology is still in question.

It is characterized by the formation of plates or nodes of a yellow or yellowish white color in the corium, and has attracted the greatest attention as a subject for dermatological study, and is usually so classified.

It is classified as to form as (1) xanthoma planum, and (2) xanthoma nodosum; as to location as (1) xanthoma palpebrarum, and (2) xanthoma multiplex. When accompanied by glycosuria it is known as xanthoma diabeticorum. The planum and nodosum varieties are regarded as different stages or degrees of the same condition. Török considers xanthoma palpebrarum as a distinct clinical entity.

In xanthoma multiplex the nodes or plaques occur on cutaneous surfaces and sometimes are found on mucous and serous membrane. It is often associated with disorders of the liver. Galloway suggests that morbid metabolic changes causing inadequate function of the liver play an important part in the disease. Chauffard, Laroche, and Thibierge, comparing the condition to gout, suggest that it bears the same relation to cholesteremia as gout with tophi formation to an excess of uric acid in the serum. The blood in this case showed a great increase in cholesterol.

Sometimes it appears hereditary, and congenital cases have been reported. It appears to be a disease of early life.

Concerning the morbid anatomy and pathology, there is a diversity of opinion. In the corium are found large multilocular connective tissue cells filled with fat. A formation of new, and a destruction of pre-existing fibrous tissue occur. The theory of a neoplastic appears to prevail over that of an inflammatory origin.

In rare cases the lesions are found on mucous and serous membranes, in the bile ducts, and arteries. The general jaundice-like pigmentation has been attributed to the partial obstruction of the bile-ducts by nodules. They have been found in tendon sheaths, the heart and the liver. On the extremities the favorite locations are about the joints, the palms and the soles, and the body folds. Morris states that "on the knuckles the growths have sometimes been found connected with the underlying tendons. In some cases they have been attached to the periosteum." MacLeod in his excellent description notes changes about the joints, especially the wrists, where the tumors appeared to be growing from the deep structures such as tendon sheaths or actual bone periosteum. He illustrates his description by a good radiogram showing erosions and irregularity of the bone (ulna) opposite the tumor.

Little has been said concerning the bone lesions in this disease, and in the descriptions of the distributions of the lesions the bones have been practically omitted. The

x-ray study is especially meager. I believe the only reference to these lesions accompanied by an x-ray description is that of MacLeod in the *British Journal of Dermatology* of November, 1913.

From the diversity of structures involved, and the histological nature of the morbid changes, it seems only reasonable that the bones should not escape and quite logical that they might share in the pathological picture.

Considering the nature of the process as described in other tissues, one might reasonably expect the bones, if involved, to exhibit areas of defect in structure representing the replacement of normal tissue by the abnormal tissue of pathological formation. The appearance of the bones confirms this suspicion. The lesions appear purely destructive, and the assumption is that the normal structure has been locally destroyed and replaced by the characteristic tissue of the process forming the dense nodules felt intimately connected with the bones.

The findings in the radiogram must be differentiated from gout, arteriosclerosis, multiple cysts, osteomyelitis, tuberculosis and syphilis. The first two especially present radiographic appearances which are practically impossible to distinguish by plate alone from those of this disease.

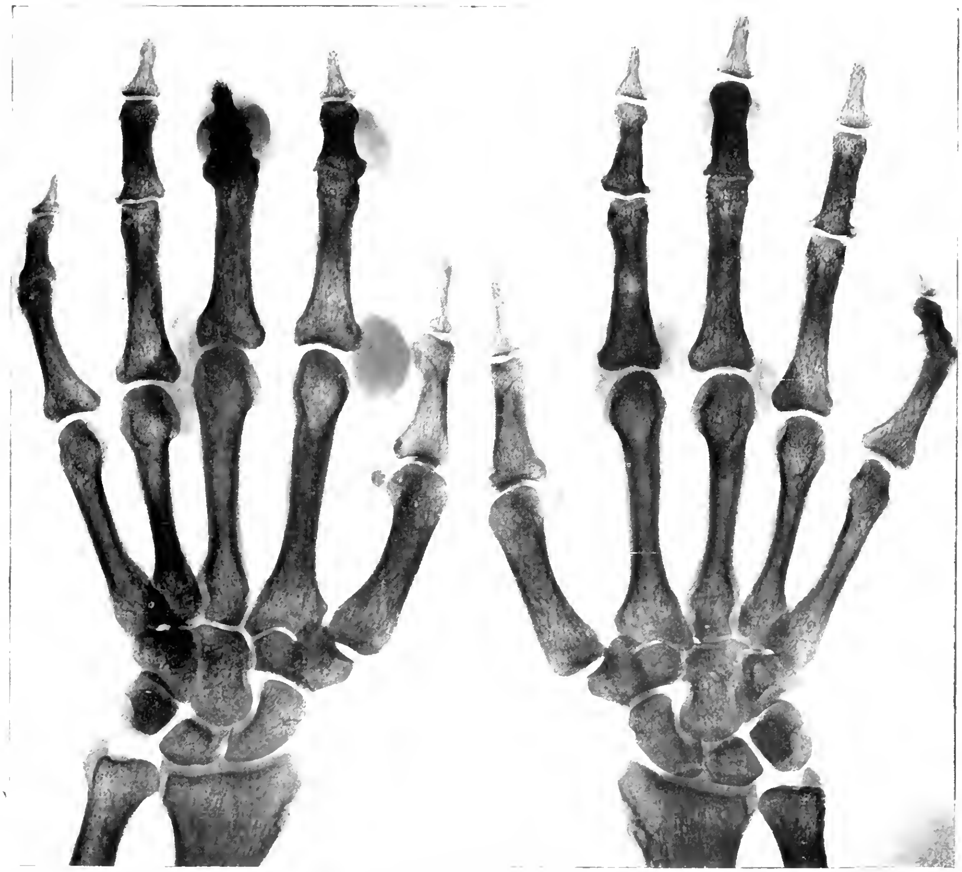


FIG. 1. SYMMETRICAL LESIONS IN 1ST AND 2ND PHALANGES OF THUMBS, 2ND PHALANGES OF FINGERS, AND ULNAE AND RADII.

From gout the lesions appear to be differentiated to a degree by the absence of involvement of the joint surfaces. Arteriosclerosis is seen as a rule at a later age, and evidence of calcification may be found in the arteries. Multiple cysts and osteitis fibrosa involve deeper bones with cyst formation,

abnormal trabeculation, thinning of the cortex, and often expansion of the weakened area, sometimes with spontaneous fracture. Osteomyelitis presents evidence of regeneration and bone repair. Tuberculosis may usually be distinguished by its origin in or near the epiphysis with rarefaction and little evidence of regeneration.

The patient in this case was a young white woman, twenty-seven years of age, of Canadian birth, unmarried, whose only occupation had been housework.

The family history presents the interesting fact that a brother had the same kind of lesions over fingers and body. Nine other brothers and three sisters were not affected, nor was either parent.

She had diphtheria at the age of seven, and "rheumatism" at twelve. Her general health has been fair. Recently she has been troubled by frequent nausea and gastric discomfort (but no pain) one or two hours after a heavy meal, accompanied by headache in frontal, temporal and occipital regions. Vomiting relieved all these symptoms. Sometimes the gastric discomfort would be relieved by exercise. She never vomited blood or passed bloody or tarry stools. Within the last few years she has complained of palpitation and some dyspnea after exertion. No pulmonary symptoms were present.

Examination of the heart was negative. The genito-urinary and neuro-muscular examinations were negative. Her usual weight remains stationary.

At about the age of seven, a few light yellow nodules appeared over the elbows, knees, and knuckles; not painful or itchy. These gradually increased in size, while new ones appeared on the body. During a period of twenty to twenty-one years they reached their present size and distribution. They were never painful or sensitive. Some of them near the joints of the fingers interfered somewhat with motion as their size increased.

Physical examination showed an eruption of papules and nodules of various size over arms, legs, feet, genital region, eyelids and chin. They were very symmetrically distributed over the extremities. With the exception of the gluteal region, the trunk was practically free from eruptions. The main findings were papules that occurred loosely over surfaces where the skin was thick and rich in subcutaneous tissue, such as the gluteal region and the flexer surfaces of the arms and legs; in the latter, including the joints, in size varying from that of a pea to that of a walnut, firm in consistency, of a yellow to brownish color, showing a definite tendency to lobulation. Smaller ones slightly elevated, but well demarcated from the surrounding skin, were of comparatively light color, yellowish red. Many of the larger ones showed a tendency to pedunculation, especially over the elbow joints. Over the fingers and toes were a few small hard tubercles about the phalangeal joints about the size of a pea, covered with practically normal skin, in most places movable, except a few which seemed connected with the underlying bony structure. The papular lesions consisted principally of small flat papules of light yellow color, well elevated, and presented no inflammatory signs. Papules of the eyelids (6 or 7 on upper lids) were about $1 \times .5$ cm. in diameter. In the gluteal region they grouped together and formed large patches, smooth, flat, deep yellow plaques. Scattered around these plaques were many small discrete papules. The largest patch was about 10 cm. in diameter, covering the gluteal region on either side. Smaller plaques were found at the bend of the elbows and knees, comparatively more elevated and of darker color than those of the gluteal region. The patches showed a tendency to peripheral extension. Nodules around the joints were of a rather firm consistency, covered by pigmented epithelium. Over fleshy areas they appeared softer, covered with epithelium of the same nature, some forming large plaques as mentioned. Some of the tumors occurring over the joints were very hard and seemed attached to the bones.

The lesions present in this case were, briefly:

1. Nodules of eyelids.

2. Nodules around joints, hands, elbows, knees, and feet.

3. Flat tumors over soft tissues.

The palms and soles were free.

The interesting features were the different types of lesion: soft and moderately hard, covered by pigmented epithelium, very hard ones covered by normal epithelium suggesting exostoses, marked symmetry, occurrences in locations where there was liability to friction or pressure, absence of joint involvement.

Three months later, report of blood after high fat diet showed tremendous increase in cholesterol. Fat lower than before.

Multiple xanthomata of hand: excision.

Several tumors of left hand excised; one over metacarpophalangeal joint of index finger found to involve extensor tendon which was trimmed down to normal dimension. Joint itself not involved. Three weeks later excision of tumor of left hand and fingers.

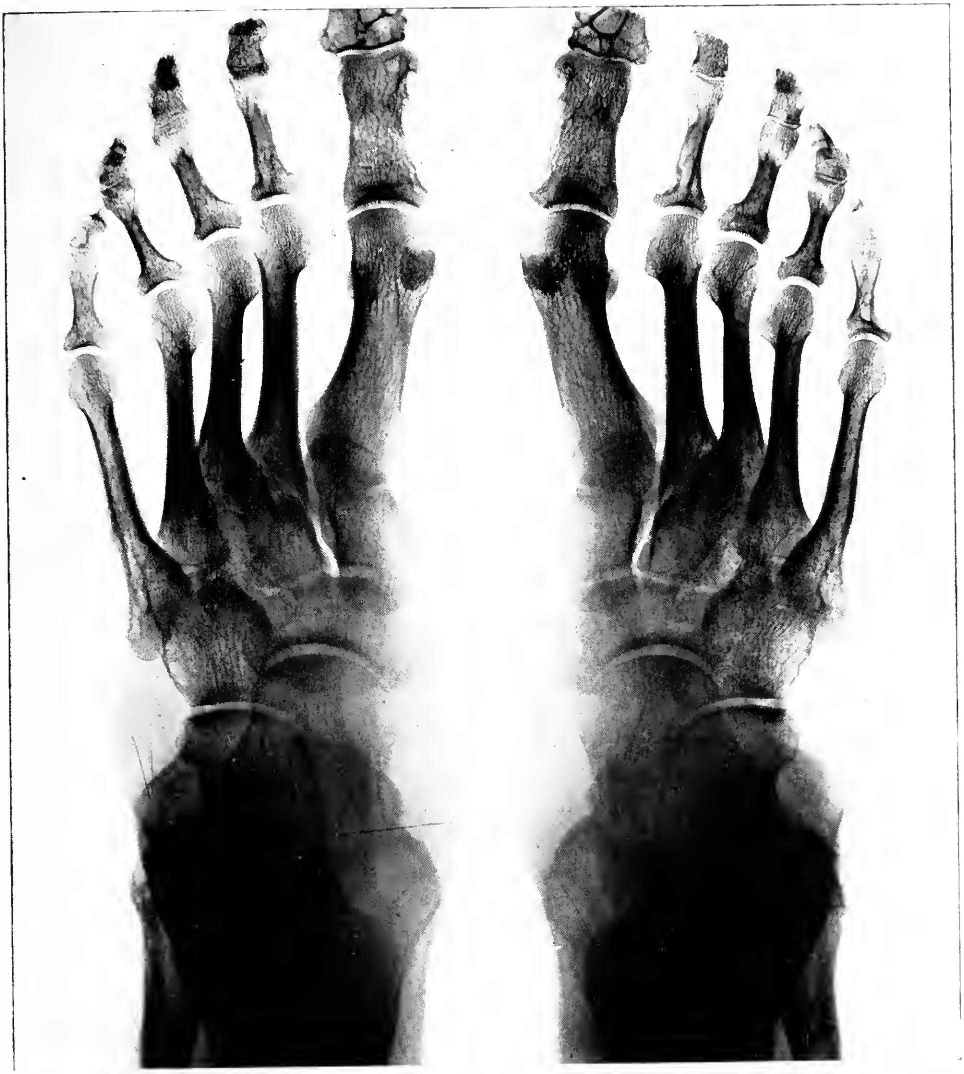


Fig. 2. Symmetrical Lesions in 1st and 2nd Phalanges 1st Toes, 1st Phalanges 2nd and 5th Toes and 5th Metatarsals.

Pathological Report.—Elbow: Hard yellow nodular tumor covered with skin and composed on section of spherical firm yellow

nodules 19 x 18 mm., banded together by connective tissue. Microscopic examination showed tumor composed of fibroblasts forming a mass of network and containing many large vacuolated cells resembling endothelial leukocytes. There were notable light spaces between the fibrils which probably contained cholesterin crystals. About these spaces were small collections of giant cells.

X-Ray Report.—In the soft tissues were many nodular enlargements. Underlying several of these superficial lesions was seen a definite abnormality of bone characterized by destruction which in some of the smaller bones was of cystic nature, in larger bones showed irregular surface destruction with partially outlined margins, most noticeable in the phalanges, metatarsals, lower end of fibulae and ulnae. In the knees and elbows where the superficial lesions were less elevated and more movable there was little or no change.

The findings in this case suggest, or rather confirm the previous belief, that this disease is a systemic condition in which many of the body tissues may be involved, of which the predominant skin lesions are only a striking surface manifestation, and in which the bones may share in the process with the other tissues.

The accompanying plates illustrate the bone changes observed.

"X-RAY"

My father is a Doctor Man,
And he does the queerest things;
Finds hooks and eyes and safety pins,
Down little babies' long red lanes.
The "Grown-ups" all have aches and pains,
And sometimes have the queerest names.
He takes *them* in a room that's dark,
And pulls a switch that makes a spark.
He says, "Now steady, hold your breath!"
The spark goes "buz-z-z-z," and he says, "All
right!"
And last he asks them "Name and Age,"
And "When they've had a fall."
But now *I'll* tell you,
'Tis very strange to say,
That all this rigmarole is simply called—

X-RAY!

Helen Ashbury.
[Age twelve years.]

UNFILTERED AND FILTERED X-RAY DOSAGE

By WILLIAM D. WITHERBEE, M.D.

Roentgenologist, Rockefeller Institute,

AND

JOHN REMER, M.D.

Roentgenologist, Vanderbilt Clinic, College of Physicians and Surgeons, Columbia University

NEW YORK CITY

THE standard of all roentgen ray dosage is known as the erythema dose; in other words, the quantity of roentgen ray necessary to produce an erythema of the skin in from ten to fourteen days after exposure.

UNFILTERED *x*-RAY DOSAGE.

The amount of radiation reaching the skin of the part exposed is determined by four fundamental factors: the voltage, expressed as K V or kilovolts; the milliamperage or current, expressed as M A or milliamperes; the time, expressed as T in minutes, and the distance, expressed as D in inches from the target of the tube to the skin. Voltage, or K V, is very often expressed in the number of inches between the spark gap terminals which relatively correspond to the number of kilovolts. The actual determination of the spark gap is obviously just the amount of pressure or voltage that gives a spark across the terminals without the tendency to arc, and which, at the same time, maintains the milliamperage desired in the tube.

The analysis of these four factors necessitated maintaining three of them constant throughout the exposure, and varying the one under investigation. Thus, maintaining 3 Sp G 3 M A for five minutes at a distance of 8 inches produced an erythema in the usual time, ten to fourteen days, over an area of the chest which happened to be covered with hair. The third week after exposure the hair came out and showed no signs of returning at the end of six months. Another area of the chest was exposed and given 3 Sp G 3 M A at a distance of 8 inches for four minutes instead of five minutes. In this area the hair fell out during the third week, and had all returned by the fourth month after exposure.

The latter formula, namely, 3 Sp G 3 M A, four minutes with 8 inch distance, we will call one skin unit. This, then is the dose required for the treatment of ringworm of the scalp, thus insuring the return of the hair, whereas if five-minute exposures were used the hair would not return, and a certain amount of permanent baldness would ensue.

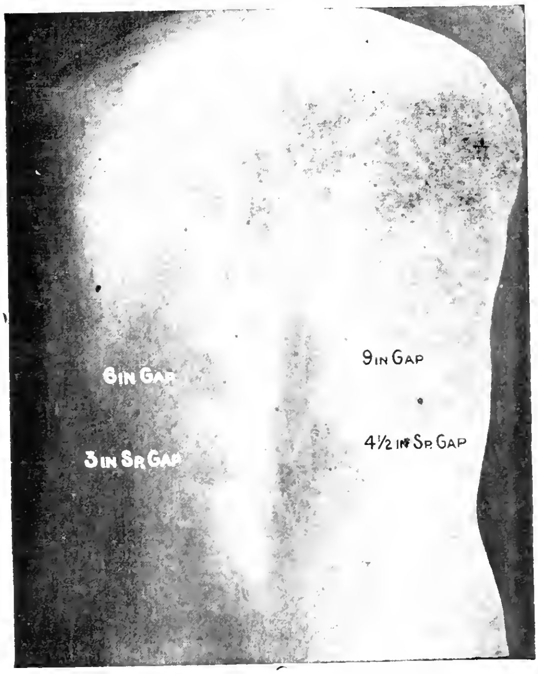


FIG. 1. FOUR AREAS OF PATIENT'S BACK TREATED WITH THE ROENTGEN RAY.

If a pastille were placed 8 inches from the target of the tube and the factors 3 Sp G 3 M A and four minutes time given, the color produced on the pastille would correspond to one on the scale of a Holzknecht

radiometer which, expressed in Holzknecht units, would be 4 H, because Holzknecht readings were originally all made at half distance.

By using the pastilles and a Holzknecht radiometer, it has been found that if you double the time, the voltage, or milliamperage separately, maintaining the other three factors constantly, you will double the dose when the roentgen ray is used without a filter; also that by placing two pastilles, one at full distance, and the other at half the distance from the target of the tube to the skin, the pastille reading at the half distance will be four times that of the one placed on the skin or full distance, therefore inversely to the square of the distance, the same as the law of light.

3 Sp G	3 M A	8 D	2 minutes=½	skin unit
6 Sp G	3 M A	8 D	2 minutes= 1	skin unit
3 Sp G	6 M A	8 D	2 minutes= 1	skin unit
3 Sp G	3 M A	16 D	4 minutes=¼	skin unit
3 Sp G	3 M A	8 D	4 minutes= 1	skin unit

The dose, then, of 1 skin unit, which we have adopted as our standard for unfiltered roentgen ray therapy, would be expressed as follows:

$$\frac{3 \text{ Sp G} \times 3 \text{ M A} \times 4 \text{ minutes}}{8 \text{ inch} \times 8 \text{ inch}} \text{ or } \frac{3 \times 3 \times 4}{8 \times 8} \text{ or } \frac{3 \times 3 \times \cancel{4}}{8 \times \underset{2}{\cancel{8}}} = \frac{9}{16}$$

The standard formula for an erythema dose would be:

$$\frac{3 \text{ Sp G} \times 3 \text{ M A} \times 5 \text{ minutes}}{8 \text{ inch} \times 8 \text{ inch}} \text{ or } \frac{3 \times 3 \times 5}{8 \times 8} \text{ or } \frac{45}{64}$$

In order to prove the actual working of the above formulas, let us take the factor as expressed in the above list.

1. If $\frac{3 \text{ Sp G } 3 \text{ M A } 2 \text{ minutes}}{8 \text{ inch D} \times 8 \text{ inch D}}$ is used, what is the dose?

$$\frac{3 \times 3 \times \cancel{2}}{8 \times \underset{4}{\cancel{8}}} = \frac{9}{32}$$

$$\frac{3 \times 3 \times 4}{8 \times 8} = \frac{36 / 4}{64 / 4} = \frac{9}{16} \text{ the standard}$$

or one skin unit

$$\frac{9}{32} \div \frac{9}{16} \text{ or } \frac{\cancel{9}}{\underset{2}{\cancel{32}}} \times \frac{\cancel{16}}{\cancel{9}} = ½ \text{ skin unit}$$

2. With 6 Sp G instead of 3 Sp G, other factors remaining constant, the process would be:

$$\frac{\overset{3}{\cancel{6}} \times 3 \times \cancel{2}}{8 \times \underset{\underset{2}{\cancel{4}}}{\cancel{8}}} = \frac{9}{16}$$

$$\frac{9}{16} \div \frac{9}{16} = \frac{\cancel{9}}{\cancel{16}} \times \frac{\cancel{16}}{\cancel{9}} = 1 \text{ skin unit}$$

3. With 6 M A instead of 3 M A, other factors remaining constant, thus:

$$\frac{3 \times \overset{3}{\cancel{6}} \times \cancel{2}}{8 \times \underset{\underset{2}{\cancel{4}}}{\cancel{8}}} = \frac{9}{16}$$

$$\frac{9}{16} \div \frac{9}{16} = \frac{\cancel{9}}{\cancel{16}} \times \frac{\cancel{16}}{\cancel{9}} = 1 \text{ skin unit}$$

4. With 4 minutes time instead of 2 minutes' time, the result would be:

$$\frac{3 \times 3 \times \cancel{4}}{8 \times \underset{2}{\cancel{8}}} = \frac{9}{16}$$

$$\frac{9}{16} \div \frac{9}{16} = \frac{\cancel{9}}{\cancel{16}} \times \frac{\cancel{16}}{\cancel{9}} = 1 \text{ skin unit}$$

5. With 16 inches distance instead of 8 inches and 4 minutes time with 3 M A and 3 Sp G, the result is:

$$\frac{3 \times 3 \times \cancel{4}}{16 \times \underset{4}{\cancel{16}}} = \frac{9}{64}$$

$$\frac{9}{64} \div \frac{9}{16} = \frac{\cancel{9}}{\underset{4}{\cancel{64}}} \times \frac{\cancel{16}}{\cancel{9}} = ¼ \text{ skin unit}$$

Now let us take the factors as given under 1, but assume that you want to use 3 Sp G 3 M A and 8 inches distance, and desire to give one half of a skin unit and do not know how much time to use.

$$\frac{3 \times 3 \times T}{8 \times 8} = \frac{9}{64}$$

The standard for 1 skin unit is $\frac{9}{16}$; for ½ of a skin unit it would be $\frac{9}{32}$ If, then, $\frac{9}{64}$ represents all of the factors except time, and $\frac{9}{32}$ equals ½ skin unit,

$$\frac{9}{32} \div \frac{9}{64} = \frac{\cancel{9}}{\cancel{32}} \times \frac{\cancelto{2}{64}}{\cancel{9}} = 2 \text{ minutes' time.}$$

With the factors expressed in 2, what would the Sp G be using 3 M A 2 minutes time at 8 inches distance to produce 1 skin unit?

$$\frac{Sp\,G \times 3 \times \cancel{2}}{8 \times \cancelto{4}{8}} = \frac{3}{32}$$

$\frac{9}{16} = 1$ skin unit, therefore,

$$\frac{9}{16} \div \frac{3}{32} = \frac{\cancelto{3}{9}}{\cancel{16}} \times \frac{\cancelto{2}{32}}{\cancel{3}} = 6 \text{ Sp G}$$

With the factors expressed in 3, what would the M A be using 3 Sp G for 2 minutes time and 8 inches distance to produce 1 skin unit?

$$\frac{3 \times M\,A \times \cancel{2}}{8 \times \cancelto{4}{8}} = \frac{3}{32}$$

$\frac{9}{16} = 1$ skin unit, therefore,

$$\frac{9}{16} \div \frac{3}{32} = \frac{\cancelto{3}{9}}{\cancel{16}} \times \frac{\cancelto{2}{32}}{\cancel{3}} = 6 \text{ M A}$$

With the factors expressed in 4, at what distance would it be necessary to place the patient from the target of the tube to produce 1 skin unit, using 3 Sp G 3 M A 4 minutes time?

$$\frac{3 \times 3 \times 4}{D \times D} = \frac{36}{D \times D}$$

$\frac{9}{16} = 1$ skin unit, therefore,

$$\frac{36}{D^2} \div \frac{9}{16} = \frac{\cancelto{4}{36}}{D^2} \times \frac{16}{\cancel{9}} = \sqrt{\frac{64}{D^2}} = \frac{8}{D}$$

D = 8 inches distance.

The distance required to produce one skin unit is found by dividing the product of the three known factors by the standard formula for one skin unit $\frac{9}{16}$ instead of dividing the standard formula $\frac{9}{16}$ by the fraction with unknown distance as exemplified in obtaining the other factors.

The determination of distance and the number of skin units are both obtained by the same method.

From the foregoing calculations it is evident that the dose of unfiltered roentgen ray can be accurately and easily determined for both fractional and massive dosage. When all four factors are known, the product of their formula divided by the product of the standard formula for one skin unit, namely, $\frac{9}{16}$, will indicate the dosage in skin units. When, however, any one of the four factors is unknown and the other three decided on, the product of the standard formula for one skin unit, namely, $\frac{9}{16}$, divided by the product of the three known factors, indicates the unknown factor for one skin unit. When distance is the unknown factor, note the exception to this rule.

Owing to a proportionately large filtration of the ray generated below a 3 inch gap by the glass in the Coolidge tube, the above rule of unfiltered dosage does not apply.

This method of estimating roentgen ray dosage is also applicable in determining the number of plates that can be taken of a given case without the production of a permanent alopecia or roentgen ray burn.

For instance, how many plates or exposures can be made of a frontal sinus or anteroposterior diameter of the head without producing an epilation or erythema of the scalp? The formula or factors for such an exposure might be as follows:

Sp G	M A	D	T
5½	25	18 in.	10 sec.

This means that the plate is 18 inches from the target of the tube, and in this instance the scalp is 10 inches from the anode. In order to find the dosage which the scalp will receive, the formula must be changed from 18 inches to 10 inches.

Sp G	M A	D	T
$5\frac{1}{2}$	25	10 in.	10 sec. $= \frac{1}{6}$ of a minute

$$\frac{5\frac{1}{2} \times 25 \times \frac{1}{6}}{10 \times 10} = \frac{\frac{275}{12}}{100} = \frac{11}{48}$$

Take the standard formula for an erythema dose:

$$\frac{3 \times 3 \times 5}{8 \times 8} = \frac{45}{64}$$

Divide the erythema dose by the dose for each exposure:

$$\frac{45}{64} \div \frac{11}{48} = \frac{45}{\underset{4}{64}} \times \frac{\overset{3}{48}}{11} = \frac{135}{44} = 3\frac{3}{44} \text{ plates}$$

Thus three plates with these factors would not cause an erythema, but may produce a temporary alopecia.

By dividing the product of the factors of the standard formula for an erythema dose, namely, $\frac{45}{64}$, or one skin unit $\frac{9}{16}$, by an exposure formula, provided the skin distance is taken instead of plate distance, the roentgenologist can determine the number of plates he can make without producing an erythema or temporary epilation.

Four areas of a patient's back were treated with the following factors for each area:

(1) $\frac{3 \times 3 \times 5}{8 \times 8} = 1\frac{1}{4}$ skin unit

(2) $\frac{3 \times 6 \times 2\frac{1}{2}}{8 \times 8} = 1\frac{1}{4}$ skin unit

(3) $\frac{3 \times 4\frac{1}{2} \times 3\frac{1}{3}}{8 \times 8} = 1\frac{1}{4}$ skin unit

(4) $\frac{3 \times 9 \times 1\frac{2}{3}}{8 \times 8} = 1\frac{1}{4}$ skin unit

The photograph of the patient taken ten days after treatment demonstrates that all the areas coincide, yet in two of them, namely, (2) and (4), the spark gap or Sp G is doubled and one-half the time taken for exposure that was given in (1) and (3) respectively. It therefore follows that if the Sp G is doubled and the time reduced one-half, the same degree of erythema will be produced, other factors remaining constant.

From the standpoint of quality of the roentgen ray in the above experiment the formula with 6 Sp G should give a very large proportion of penetrating rays as compared with the 3 Sp G and 4½ Sp G. Hence one would expect that these penetrating rays derived from the higher Sp G would pass through the skin, and it would take much longer to produce the same erythema as was produced by the 3 Sp G and 4½ Sp G formulas which give a large proportion of rays of low penetration, and naturally would be absorbed in the outer layers of the skin and quickly produce a burn.

By actual experiment the reverse proves true. For it took just one-half the time to produce the same biologic effect in the doubled Sp G doses (6 Sp G and 9 Sp G) as it did in the 3 Sp G and 4½ Sp G formula.

It is, then, apparent that quality of the ray and absorption of the rays of long wave have little to do with the biologic effects in the skin. On the other hand, it seems that the factor which determines this effect is solely the quantity of roentgen ray reaching the skin, for it is obvious that a high Sp G produces more rays that reach the skin than the same dose with a low Sp G or spark gap.

We published the original communication establishing the principles and practical application of this method for both filtered and unfiltered dosage in the June issue of The American Journal of Roentgenology, 1917. Since the date of that publication Drs. MacKee[1] and Wise[2] have, in their respective papers, pointed out the efficacy of this method in the calculation of roentgen ray dosage in dermatology.

FILTERED X-RAY DOSAGE

The method of estimating filtered dosage differs from that of unfiltered in that each thickness of aluminum requires a separate standard or formula for one skin unit.

¼ mm. aluminum

$$\frac{9 \text{ in. gap } 5 \text{ MA} \times 42 \text{ sec.}}{10 \text{ in. dist.}} =$$

$$\frac{9 \times 5 \times \frac{\cancel{42}^{7}}{\cancel{60}_{10}}}{\cancel{10}_{2}} = \frac{\frac{63}{10}}{2} = \frac{63}{20}$$

½ mm. aluminum

$$\frac{9 \times 5 \times 1 \text{ min. } 6 \text{ sec.}}{10} =$$

$$\frac{9 \times 5 \times \frac{\cancel{66}^{11}}{\cancel{60}_{10}}}{\cancel{10}_{2}} = \frac{\frac{99}{10}}{2} = \frac{99}{20}$$

1 mm. aluminum

$$\frac{9 \times 5 \times 1 \text{ min. } 54 \text{ sec.}}{10} =$$

$$\frac{9 \times \cancel{5} \times \frac{\cancel{114}^{57}}{\cancel{60}_{30}}}{\cancel{10}_{2}} = \frac{\frac{513}{30}}{2} = \frac{513}{60} = \frac{171}{20}$$

2 mm. aluminum

$$\frac{9 \times 5 \times 2 \text{ min. } 20 \text{ sec.}}{10} =$$

$$\frac{\overset{3}{\cancel{9}} \times \cancel{5} \times \frac{\cancel{140}^{7}}{\cancel{60}_{\cancel{3}}}}{\cancel{10}_{2}} = \frac{21}{2}$$

3 mm. aluminum

$$\frac{9 \times 5 \times 2 \text{ min. } 34 \text{ sec.}}{10} =$$

$$\frac{\overset{3}{\cancel{9}} \times \cancel{5} \times \frac{\cancel{154}^{77}}{\cancel{60}\ \cancel{30}\ \cancel{6}\ 2}}{10} = \frac{\frac{231}{2}}{10} = \frac{231}{20}$$

4 mm. aluminum

$$\frac{9 \times 5 \times 4 \text{ min.}}{10} = \frac{9 \times \cancel{5} \times \overset{2}{\cancel{4}}}{\cancel{10}_{\cancel{2}}} = 18$$

5 mm. aluminum

$$\frac{9 \times 5 \times 7 \text{ min.}}{10} = \frac{9 \times \cancel{5} \times 7}{\cancel{10}_{2}} = \frac{63}{2}$$

6 mm. aluminum

$$\frac{9 \times 5 \times 7 \text{ min.}}{10} = \frac{63}{2}$$

7 mm. aluminum

$$\frac{9 \times 5 \times 7 \text{ min.}}{10} = \frac{63}{2}$$

The time factor differs from unfiltered in its action on the skin and pastille with a 6 inch gap or less when the four factors are used that produce 1 skin unit and then a doubling of the time, other factors remaining constant, a reading of 1¼ skin units will be obtained. For each time that this process is repeated, the reading will advance one quarter of a skin unit.

A 7 inch gap gives 1½ skin units when double the time to produce 1 skin unit is used, and then begins to advance at the rate of one quarter of a skin unit for each exposure time thereafter.

The 8, 9 and 10 inch gaps, with three times the time exposure for one skin unit, gives two skin units, and then begins to advance at the rate of one-quarter skin unit for each exposure time. The only exception to this rule is when 5, 6 or 7 mm. aluminum are used, twice the time produces two skin units and then advances by half units to 3.

To illustrate the above, we will give below a list of readings made and reported by us in the original article.

Gap	MA	D	T	P
6	5	10	3 min. 51 sec. = 1	skin H
6	5	10	7 min. 42 sec. = 1¼	skin H
6	5	10	11 min. 33 sec. = 1½	skin H
6	5	10	15 min. 24 sec. = 1¾	skin H
6	5	10	19 min. 15 sec. = 2	skin H

Gap	MA	D	T	P
7	5	10	3 min. 18 sec. = 1	skin H
7	5	10	6 min. 36 sec. = 1½	skin H
7	5	10	9 min. 54 sec. = 1¾	skin H
7	5	10	13 min. 12 sec. = 2	skin H
7	5	10	16 min. 30 sec. = 2¼	skin H
7	5	10	19 min. 48 sec. = 2½	skin H
7	5	10	23 min. 6 sec. = 2¾	skin H
7	5	10	26 min. 28 sec. = 3	skin H

Gap	MA	D	T	P
8	5	10	2 min. 53 sec. = 1	skin H
8	5	10	5 min. 46 sec. = 1½	skin H
8	5	10	8 min. 39 sec. = 2	skin H
8	5	10	11 min. 32 sec = 2¼	skin H
8	5	10	14 min. 25 sec. = 2½	skin H
8	5	10	17 min. 18 sec. = 2¾	skin H
8	5	10	20 min. 11 sec. = 3	skin H

Gap	MA	D	T	P
9	5	10	2 min. 34 sec. = 1	skin H
9	5	10	5 min. 8 sec. = 1½	skin H
9	5	10	7 min. 42 sec. = 2	skin H
9	5	10	10 min. 16 sec. = 2¼	skin H
9	5	10	12 min. 50 sec. = 2½	skin H
9	5	10	15 min. 24 sec. = 2¾	skin H
9	5	10	17 min. 58 sec. = 3	skin H

Gap	MA	D	T	P
10	5	10	2 min. 19 sec. = 1	skin H
10	5	10	4 min. 38 sec. = 1½	skin H
10	5	10	6 min. 57 sec. = 2	skin H
10	5	10	9 min. 16 sec. = 2¼	skin H

Distance in filtered dosage, instead of obeying the law of light, produces double the effect at half distance instead of four times as in unfiltered ray. To substantiate this statement, the following factors were used with 3 mm. aluminum:

Sp. G	MA	D	T	P
9	5	6	7 min. 42 sec.	2½ skin units
9	5	12	15 min. 24 sec.	2½ skin units

A patient's wrists were placed beneath the tube, one at 6 inches distance from the target, the other at 12 inches, both wrists being exposed at the same time. The one at 6 inch distance was withdrawn at half time (7 min. 42 sec.) the other continued to full time exposure (15 min. 24 sec.) at 12 inch distance.

Ten days after the exposure, the erythema produced on each wrist was identical, thereby demonstrating that at full distance, doubling the time of half distance produces the same biological effect. This, then, establishes the fact that distance in filtered ray does not obey the same law as in unfiltered dosage. Hence the difference in the formula.

Unfiltered formula:

$$\frac{3 \times 3 \times 4}{8 \times \underset{2}{\cancel{8}}} = \frac{9}{16} = 1 \text{ skin unit}$$

Filtered formula, with 4 mm. aluminum.

$$\frac{9 \times 5 \times \overset{2}{\cancel{4}}}{\underset{5}{\cancel{10}}} = 18 = 1 \text{ skin unit}$$

Pastille readings of filtered doses at full distance compared with biological and formulae determinations may be found in a recent article published in the *New York Medical Journal.*[4]

Spark gap and milliamperes in filtered dosage obey the same law as in unfiltered, namely, double the gap or double the M A equals double the dose.

The above experiment on patients' wrists has been duplicated on the backs of other patients by using two areas exposing one 7 minutes and 42 seconds and the other 15 minutes and 24 seconds with the other factors the same as a check on the findings reported on the wrists.

The employment of a formula to determine the amount of filtered dosage is not so simple as in unfiltered dosage, owing to the different thickness of the filter employed and the difference in the time factor, as pointed out above on 6, 7, 8, 9 and 10 inch gaps.

However, where aluminum is used as a filter, if one knows the factors that produce 1 skin unit with 3 mm. aluminum, it is not difficult to determine any dose where 3 mm. aluminum is used. For example, we know that 9 in. Sp G, 5 M A, 2 min. 34 sec., at 10 inch distance gives one skin unit with 3 mm. aluminum. How much time, with these as a standard, will it take to produce an erythema dose, namely 2½ skin units using 8 inch gap, 5 M A, at 10 inch distance with 3 mm. aluminum?

$$\frac{9 \times 5 \times 2 \text{ min. } 34 \text{ sec.}}{10} =$$

$$\frac{9 \times 5 \times \overset{77}{\cancel{154}}}{\underset{2}{\cancel{10}}} = 693 = 1 \text{ skin unit}$$

$$\frac{\overset{4}{\cancel{8}} \times 5 \times T}{\underset{2}{\cancel{10}}} = 4$$

$693 \div 4 = 173\frac{1}{4}$ sec. = 2 min. 53 sec. = 1 skin unit.

If it takes 154 seconds with a 9 inch gap to produce 1 skin unit, it will take as many seconds to produce 1 skin unit with an 8 inch gap as 4 is contained in 693, or $173\frac{1}{4}$ sec. = 2 min. 53 sec. In order to determine the time necessary for an erythema dose ($2\frac{1}{2}$ skin units) we must know that an 8 inch gap requires three times the exposure for 1 skin unit (2 min. 53 sec.) to produce two skin units, which is 3 × (2 min. 53 sec.) = 8 min. 39 sec., and then it requires twice the time of one skin unit (2 × [2 min. 53 sec]) = 5 min. 46 sec. added to the time for two skin units to produce $2\frac{1}{2}$ skin units or an erythema dose. Thus 8 min. 39 sec. + 5 min. 46 sec. = 14 min. 25 sec., the time for $2\frac{1}{2}$ skin units using 8 inch gap, 5 M A, and 10 inch distance.

What is the dose when 4 mm. aluminum is used with 9 inch gap, 5 M A, 12 minutes time at 10 inch distance? The standard one skin unit with 4 mm. aluminum is $\frac{9 \times 5 \times 4}{10}$ = 1 skin unit. If it takes 4 minutes to produce 1 skin unit, it will take 12 minutes to produce 2 skin units, because it takes three times the time of 1 skin unit to produce 2 skin units with a 9 inch gap.

What would be the dose using 8 inch gap, 5 M A, 8 inch distance, and 10 minutes time with 3 mm. aluminum? The standard for 1 skin unit with 3 mm. aluminum is:

$$\frac{9 \times 5 \times 2 \text{ min. } 34 \text{ sec.}}{10} =$$

$$\frac{\overset{3}{\cancel{9}} \times 5 \times \frac{\overset{77}{\cancel{154}}}{\cancel{60}\ \cancel{30}\ \cancel{6}\ 2}}{10} = \frac{\frac{231}{2}}{10} = \frac{231}{20}.$$

In order to determine the dose for the factors given $\left(\frac{8 \times 5 \times 10}{8}\right)$ we must first find the amount of time necessary to produce one skin unit with these factors.

Thus $\frac{\cancel{8} \times 5 \times T}{\cancel{8}} = 5.$

the standard for one skin unit with 3 mm. aluminum ($\frac{231}{20}$) divided by 5 will give the time necessary.

$$\frac{231}{20} \times \frac{1}{5} = \frac{231}{100} = 2\frac{31}{100} \text{ min.} = 2 \text{ min. } 18 \text{ sec.}$$

If 2 minutes and 18 seconds is the time required for one skin unit, with 8 inch gap, 5 M A at 8 inch distance, it will take 4 minutes and 36 seconds to produce $1\frac{1}{2}$ skin units, and 6 minutes 57 seconds to produce 2 skin units, 9 minutes and 12 seconds to produce $2\frac{1}{4}$ skin units, with 48 seconds remaining. Ten minutes, then, would produce approximately a total of 2 1/3 skin units.

What would be the dose at 20 inch distance instead of 10 inch, with 4 mm. aluminum, 8 minutes time?

The standard for 1 skin unit with 4 mm. aluminum is

$$\frac{9 \times 5 \times \overset{2}{\cancel{4}}}{\underset{2}{\cancel{10}}} = 18.$$

The proposed factors are

$$\frac{9 \times 5 \times \overset{2}{\cancel{8}}}{\underset{4}{\cancel{20}}} = 18.$$

Therefore, to find the dose, divide by the standard formula, $18 \div 18 = 1$ skin unit.

Therefore, double time and double distance of the respective factors of one skin unit produces the same results with the formula as with the biological reaction.

It therefore becomes necessary in order to determine dosage of *x*-rays filtered through aluminum to know at least one complete set of factors as a standard that will produce 1 skin unit with a certain thickness of aluminum. Also to remember that a 6 inch gap or less begins quartering after 1 skin unit, 7 inches after $1\frac{1}{2}$ skin units, and 8, 9 and 10 inches after 2 skin units. Also that a 9 inch gap using 5, 6 or 7 mm. aluminum doubles the time of 1 skin unit = 2 skin units, and then increases at the rate of one-half skin unit.

In a recent sisue of the *New York Medical Record*[5] the relation of the erythema dose of unfiltered and filtered *x*-ray was found to be 1 to 2 according to Holzknecht scale, namely $1\frac{1}{4}$ skin units unfiltered $= 2\frac{1}{2}$ skin units filtered. Assuming that these formulae and the methods given here are correct from biological results obtained, it is quite evident that the effects produced both by the unfiltered and filtered ray are controlled by laws entirely different from those determining plate dosage or intensity of light.

We believe that these methods of determining dosage are practical, providing an original Coolidge *x*-ray tube with solid tungsten target and interruptless machine is used.

BIBLIOGRAPHY

1. MacKee, George M. Arithmetical Computation of Roentgen Dosage. Am. J. Roentgenol., Dec., 1919, vi, 605.
2. Wise, Fred. Roentgen Ray Treatment of Widespread and Generalized Diseases of the Skin. *J. Am. M. Assn.*, Nov. 15, 1919, lxxiii, 1491.
3. Remer and Witherbee. The Action of *X*-Rays on Plate Pastille and Skin. Am. J. Roentgenol., June, 1917.
4. Witherbee and Remer. Filtered *X*-Ray Dosage. *N. York Med. J.*, June 24, 1920.
5. Remer and Witherbee. *X*-Ray Burns. *Med Rec.*, June, 1920

THE EFFECT OF DIFFERENT FILTERS ON RADIUM RADIATIONS

By EDITH H. QUIMBY, A.M.

Radium Research Laboratory, Memorial Hospital

NEW YORK CITY

In deep radium therapy filters of various metals are used to remove the beta and soft gamma radiation. There is considerable difference of opinion as to what metal is most suitable for this purpose. For instance, some use lead almost exclusively, and others condemn its use very strongly. In any case, what is of importance is the quality of the radiation reaching the tissue. A study of the absorption in tissue of the composite radiation from a source of radium or emanation, after filtration by different substances, is therefore of considerable importance. The experiments described in the following paper were made in order to ascertain the absorption curves for several metals which may be used as filters, and then to compare the penetration of the radiation in tissue after filtration through some of these metals.

Experimental Procedure.—The apparatus used is shown in diagram in Fig. 1. The gold leaf electroscope is connected to the central wire of the conical lead ionization chamber. This wire is kept at a potential of several hundred volts. The lower end of the ionization chamber is a very thin mica window. The source of radiation is a thin glass emanation tube, supported 12 centimeters below this window in a holder of mica and hard rubber. The various filters are placed directly over the emanation tube. The tissue is supported above the tube on a holder of hard rubber with a thin mica window, so that the filters can be inserted between the source of radiation and the tissue, without disturbing either. The electroscope is protected from direct radiation from the tube by the lead block.

The ionization current is measured by observing the time necessary to discharge the electroscope, the intensity of the radiation absorbed in the chamber being inversely proportional to the time, due correction being made for the natural fall of the leaf. Thus what is actually measured is the ionization produced in the air in the ionization chamber, and this depends on the amount of radiation absorbed. There are two factors which

might affect the quantitative accuracy of the readings. First, the lead ionization chamber gives rise to secondary radiation, which is different when the primary radiation consists largely of beta rays from that produced when the primary radiation is wholly gamma rays. Second, the air in the chamber absorbs different proportions of the beta and gamma radiation from the incident beam. These facts do not at all disturb the mutual relations of the curves obtained, or the validity of the conclusions drawn from them, for comparisons are to be made between different sets of filters giving the same ionization, and in any such case the proportion of beta and gamma radiation transmitted by one metal is not very different from that transmitted by another.

For each metal, the ionization current was measured first for the bare tube and then for increasing thicknesses of the filter. The reading for the bare tube was taken as 100 per cent, and the others tabulated in terms of this, allowance being made for the decay of the emanation during the experiment. The curves thus obtained are shown in Fig. 2,

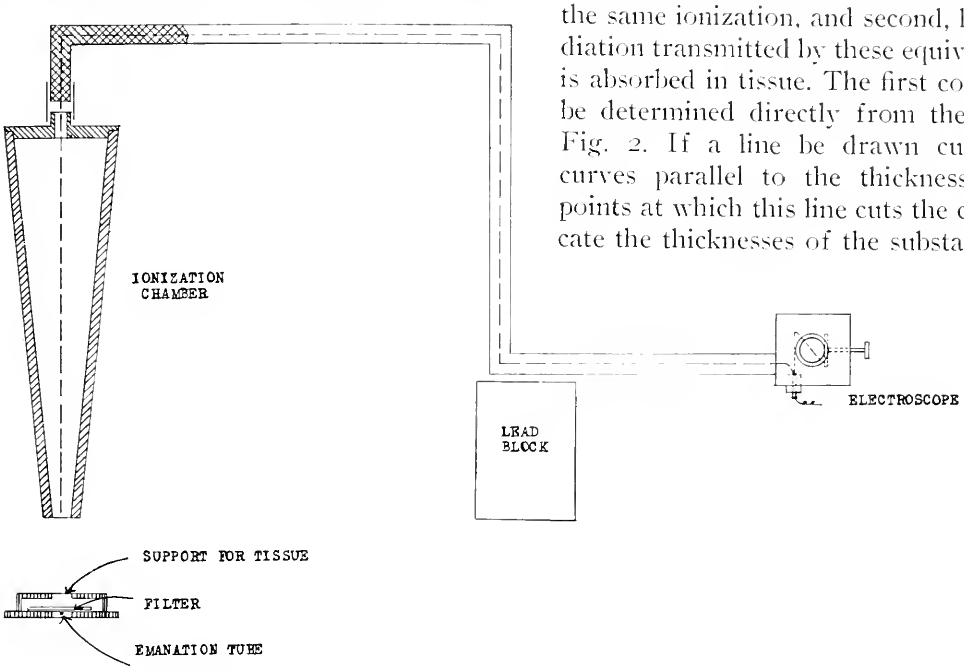


Fig. 1. Apparatus Used for Obtaining Absorption Curves for Different Metals.

and the part of them showing the transition from the predominance of beta to that of gamma radiation is repeated to a larger scale in Fig. 3.

In order to compare the quality of the radiation transmitted through different filters, it is necessary first to determine the thicknesses of the different substances which give the same ionization, and second, how the radiation transmitted by these equivalent filters is absorbed in tissue. The first condition can be determined directly from the curves of Fig. 2. If a line be drawn cutting these curves parallel to the thickness axis, the points at which this line cuts the curves indicate the thicknesses of the substances which produce the same effect in the ionization chamber. For the test, aluminum, brass and lead were selected as being substances frequently used for filters, and covering a wide range of densities.

Six sets of filters were made in the manner just described. These were tested and modified slightly until the members of each set gave substantially the same ionization current. The thicknesses used were:

Aluminum	Brass	Lead
0.60 mm.	0.16 mm.	0.08 mm.
1.20	0.32	0.16
1.78	0.48	0.25
3.34	0.96	0.58
6.11	1.92	1.10
10.78	3.04	1.33

It will be observed that these thicknesses are

not proportional to the densities of the metals, the increase in absorption with the increase in atomic weight making necessary smaller thicknesses of the denser metals.

The tissue used was beef, hardened in formalin and cut very uniformly in thin slices by means of a meat slicing machine with a specially ground knife. Tests were made to find the difference in absorption by this formalin tissue and by fresh meat, and it was found that after the first few millimeters it was practically identical. Since the results embodied in this paper are qualitative rather than quantitative, the slightly higher absorption by fresh tissue in the first few millimeters is immaterial.

The question has often been raised by medical men as to whether dead and living tissue absorb the radiations to the same extent. Physical considerations lead to the conclusion that the absorption should be the same in both cases, as long as the amounts of the chemical elements present remain the same. Since the ultimate aim of this work was the comparison of doses given patients, it was thought desirable to make a direct experimental test of this matter. Two tests were made on the absorption of the same radiation by the same tissue when alive and dead. For the beta radiation, a rabbit was so placed that its ear was just over the emanation tube, and the ionization measured as previously described. The ear was then cut off, without removing it from its position, and the ionization measured soon after, and again one hour later. No difference in the absorption of the radiation by the tissue when it was a part of the live animal and when it was cut off was found. For the gamma radiation, a rat was used, the rays traversing its body. The ionization was measured while it was alive, soon after it had been given sufficient ether to kill it, and again twelve hours later. As before, no difference was observed. Therefore these results show that the absorption of radium rays is the same for dead and living tissue, within the limits of experimental error.

Measurements of the ionization currents were made for each filter with different thicknesses of tissue. The whole series of observations was repeated several times to determine definitely the relative positions of the curves. The results are given in Table 1, and the curves plotted from this data are shown in Fig. 4, those for the thicker filters being repeated to a larger scale in Fig. 5. In these curves the vertical distance from the axis of any point on the curve represents the intensity of ionization produced in the chamber by the radiation transmitted by the filter and tissue, and the horizontal distance indicates the thickness of tissue.

Discussion of Curves.—It is evident from these curves that the radiations after transmission through these "equivalent" filters of different substances, are not absorbed to the same extent in the tissues. Curve I of Fig. 4 shows the absorption by tissue alone. In Curves II, for the thinnest filters used, the curves start together and then diverge for a time, the lead being highest and the aluminum lowest. This, of course, means that for this set the radiation transmitted by the lead is the most penetrating. Groups III and IV are essentially the same, except that for a part of the way the lead and brass coincide. But in V, the brass and aluminum coincide for a part of the way and then the aluminum is above, while both are above the lead. In the last two groups the aluminum is highest and the lead lowest throughout, just the reverse of the first condition, and these curves do not come together again after traversing some thickness of tissue.

Since the radiation from the tube of emanation used is the same in all cases, and the ionization is the same when no tissue is interposed, the explanation of the phenomenon must be sought in the action of the filters on the radiation before it reaches the tissue. As previously explained, the equivalence of these filters is determined by the effect the transmitted radiation produces in the ionization chamber. However, the quality of the radiation producing the same ionization may be quite different. The curves show that differences do exist.

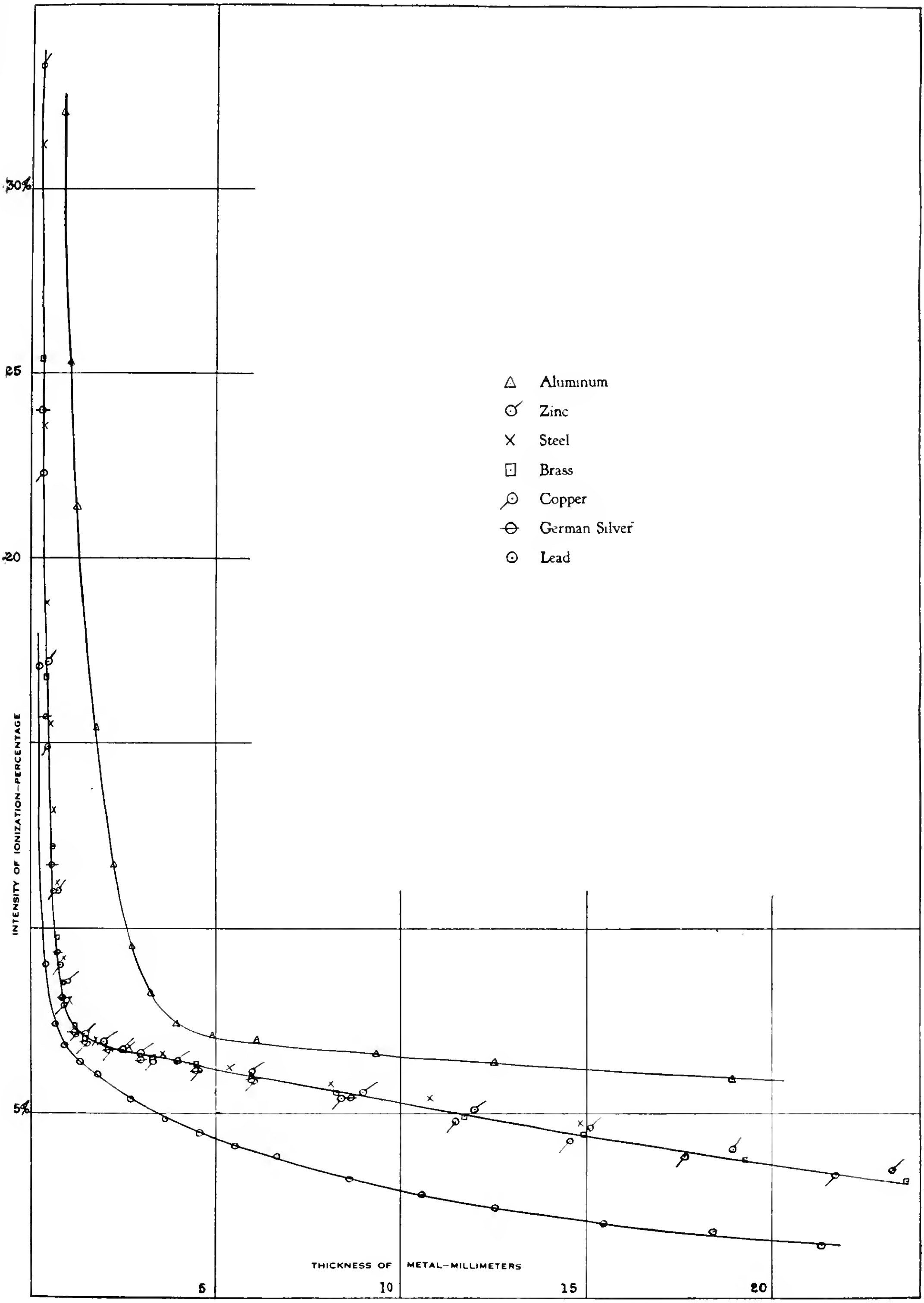


FIG. 2. CURVES SHOWING ABSORPTION OF RADIATION BY METALS.

There are three factors which are due to the filters and which may influence the shape of the curves: the true absorption of the primary radiation, the scattering of the primary radiation, and the emission of secondary radiation. These three phenomena occur whenever radiation traverses matter, and are determined by the nature of the substance traversed. They are all strictly atomic phenomena, that is, they are caused by the individual atoms, and not by the physical nature of the material. For instance, the density, or the packing of the atoms, has no influence on the absorption of the radiation per unit mass of the substance.[1] But the atomic weight, or the weight of the individual atom, is an important factor. For elements of very different atomic weights, the absorption, scattering, and secondary radiation are all different, even though account is taken of the difference in density. For instance, lead absorbs more of the beta radiation, mass per mass, than does aluminum. In other words, given a lead and an aluminum plate of equal area and equal weight, the aluminum being therefore thicker than the lead in the ratio of the densities of the metals, the lead will absorb several times as much beta radiation.[1] In the case of the gamma rays the effect is much less marked, the lead absorbing only a little more, mass per mass, than the aluminum.[2]

Besides the rays which are actually absorbed in the filter, others are scattered, and thus prevented from reaching the ionization chamber. For the beta radiation, a metal of high atomic weight scatters very much more than one of light atomic weight.[3] On the other hand, there is some evidence that for the gamma rays more scattering is produced by the light elements than by lead.[4]

Both the beta and gamma rays give rise to secondary radiation in the substance which they traverse. The secondary beta radiation thus produced varies in penetrating power with the atomic weight of the screen, that produced in lead being somewhat more penetrating than in the lighter elements.[5] The amount depends upon the thickness of the filter, increasing up to a certain point and then decreasing. The secondary gamma radiation increases rapidly in penetrating power and in amount with the atomic weight of the screen. However its amount is always only a small proportion of the primary beam, so that it is not an important factor.[6]

This absorption, scattering, and secondary radiation and their variations with the atomic weight of the elements (more properly the atomic number, which is the number representing the place of the element in the periodic table), are the factors from which the curves of Figs. 4 and 5 are to be explained. It is to be remembered that all three of these factors are acting simultaneously, and the total effect is due to their combined action.

It has been pointed out that in Curves II of Fig. 4 the radiation transmitted by the lead is evidently more penetrating than the others, for its curve shows a greater intensity of ionization for a given thickness of filter. This is what would be expected from the factors just discussed. The lead absorbs more of the beta radiation in proportion than the other substances, and the aluminum less. Also the lead scatters more of the beta radiation and the aluminum less. Both of these factors tend to make the radiation filtered through the lead consist of gamma radiation to a greater extent than that filtered through the aluminum, and therefore to be more penetrating. In addition, the secondary radiation emitted from the lead is more penetrating than that from the other metals.

Curves III are like II, except that all the radiation is now more penetrating, having passed through a greater thickness of filter. For the present the next three sets will not be considered. In the case of the last set there is a sufficient thickness of filter to cut out most of the beta radiation, so that the gamma radiation is now the controlling factor. The effects mentioned above, which tended to harden the beam from the lead, now become relatively unimportant. On the other hand, the scattering and absorption of the gamma rays are nearly the same for all substances, so that this factor is also of little consequence. There remains the secondary radiation. Lead emits a very copious second-

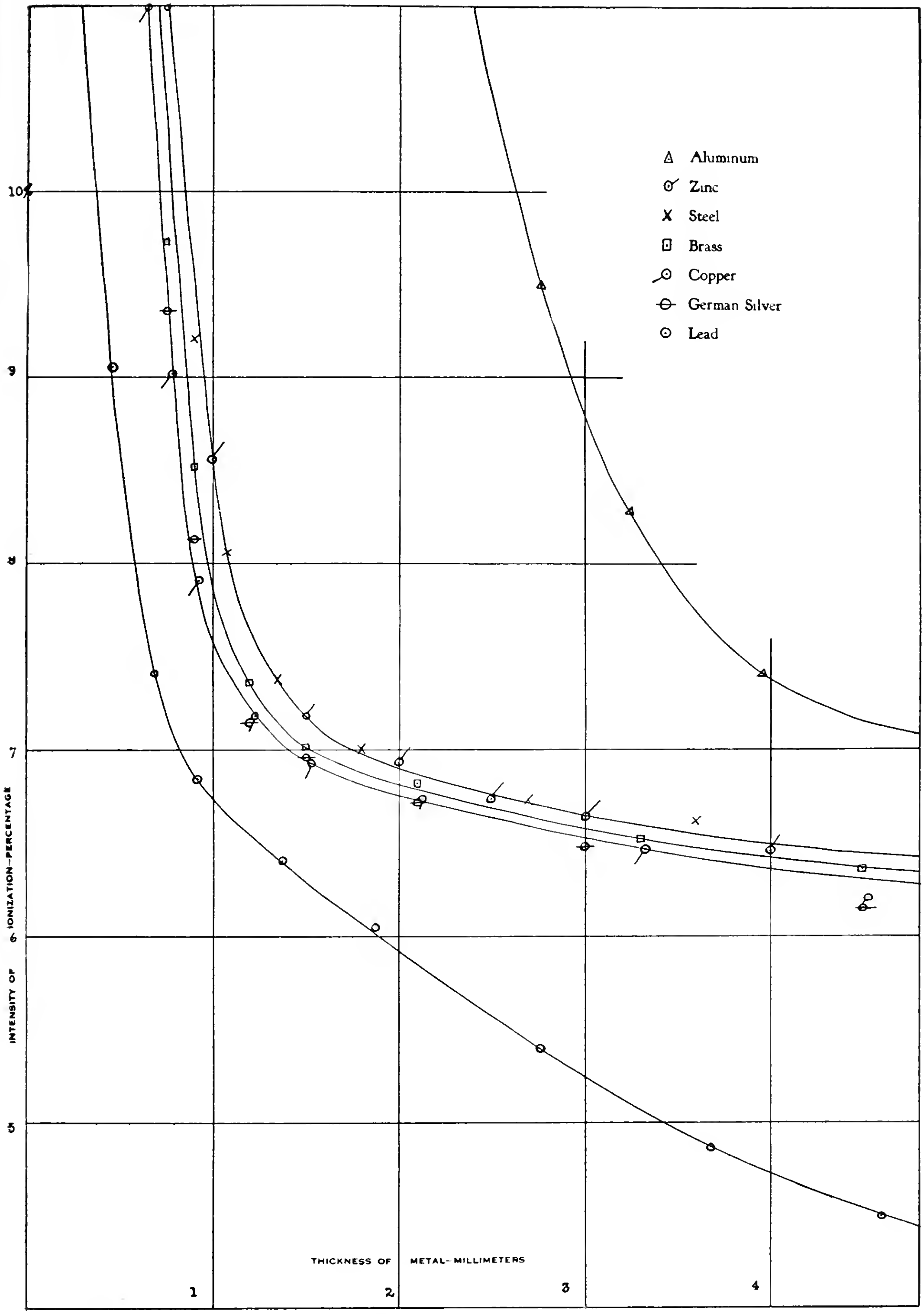


Fig. 3. Curves Showing Absorption of Radiation by Metals.

ary radiation, much more than either of the other metals. Moreover, this thickness of lead is very nearly that found by Eve [5] to be that giving a maximum secondary radiation. On the other hand, aluminum reaches its maximum at 3 millimeters and then there is a decrease in the amount. This means that the beam from the lead filter contains much more secondary radiation than the others, and this, being softer than what remains of the primary beam, is much more readily absorbed in tissue. Therefore the absorption curve for lead in this group drops rapidly during the passage through the first centimeter of tissue.

Curves VI are of the same character as VII, and subject to the same interpretation. There remain the two intermediate groups. It is evident that in the operation of two effects, one tending to make the beam from the lead more penetrating than the others, and one tending to make it more absorbable, there must be some point at which it is the same as the others, and these two groups show this transition.

The first sets of curves, after being divergent for a time, come together again. In these cases the metal filters used are thin, and with increasing thickness the tissue becomes the predominant filter. This being the same in all cases, the effect is to make the transmitted radiation the same. On the other hand, in the last sets of curves the metal filters are thick and there was never enough tissue used to make it relatively important.

The first 5 millimeters of tissue absorb about 15 per cent of the radiation filtered through 1.33 millimeters of lead, while of that from 3.04 millimeters of brass—the equivalent as determined in this experiment—only half as much is absorbed. Even this is an appreciable amount, and when thick filters are used for deep therapy, measures are usually taken to remove the secondary radiation by an additional filter which will not in itself generate more objectionable rays. Sheet rubber is often used for this, so a test was made in which the tissue was replaced by rubber for certain filters. For those of the last three groups the absorption for the first centimeter was found to be practically identical with that for tissue. The points with arrows on the curve for 1.33 millimeters of lead indicate absorption by sheet rubber instead of tissue. From this it is evident that a thickness of a few millimeters of rubber is sufficient protection against secondary radiation.

The best filter for deep therapy is one that will give a penetrating beam with as little secondary radiation as possible. Brass gives less secondary radiation than lead, therefore in this respect it is a better filter. Brass is also one of the easiest metals to machine; it does not rust; it is hard, so that the applicators keep their shape; it is inexpensive and easily procured. Furthermore, 2 millimeters of brass is a sufficient thickness to remove the soft radiation. Since the curves for 1.96 and 3.04 millimeters of brass are practically parallel, the extra millimeter of brass has not increased the relative penetration appreciably, but it has absorbed 4 per cent more of the original penetrating radiation, thus decreasing the efficiency. This argument applies more strongly when 2 millimeters of lead are used as a filter, for in this case about 10 per cent of the penetrating radiation is absorbed.

Conclusions.—Equivalent filters of different metals have been determined, which give the same intensity of ionization in the apparatus described.

When the radiation filtered through these "equivalent" thicknesses is transmitted through tissue, the ionization produced is not the same.

For thin filters, up to half a millimeter of brass or its equivalent, the radiation transmitted by lead is more penetrating than that transmitted by brass, which in turn is more penetrating than that from aluminum. When the absorption by the tissue becomes great in comparison to that by the filter, this effect is obscured.

For thick filters, equivalent to one millimeter of brass, or more, this effect is reversed, the radiation transmitted by lead having a larger percentage of soft radiation than that transmitted by brass or aluminum.

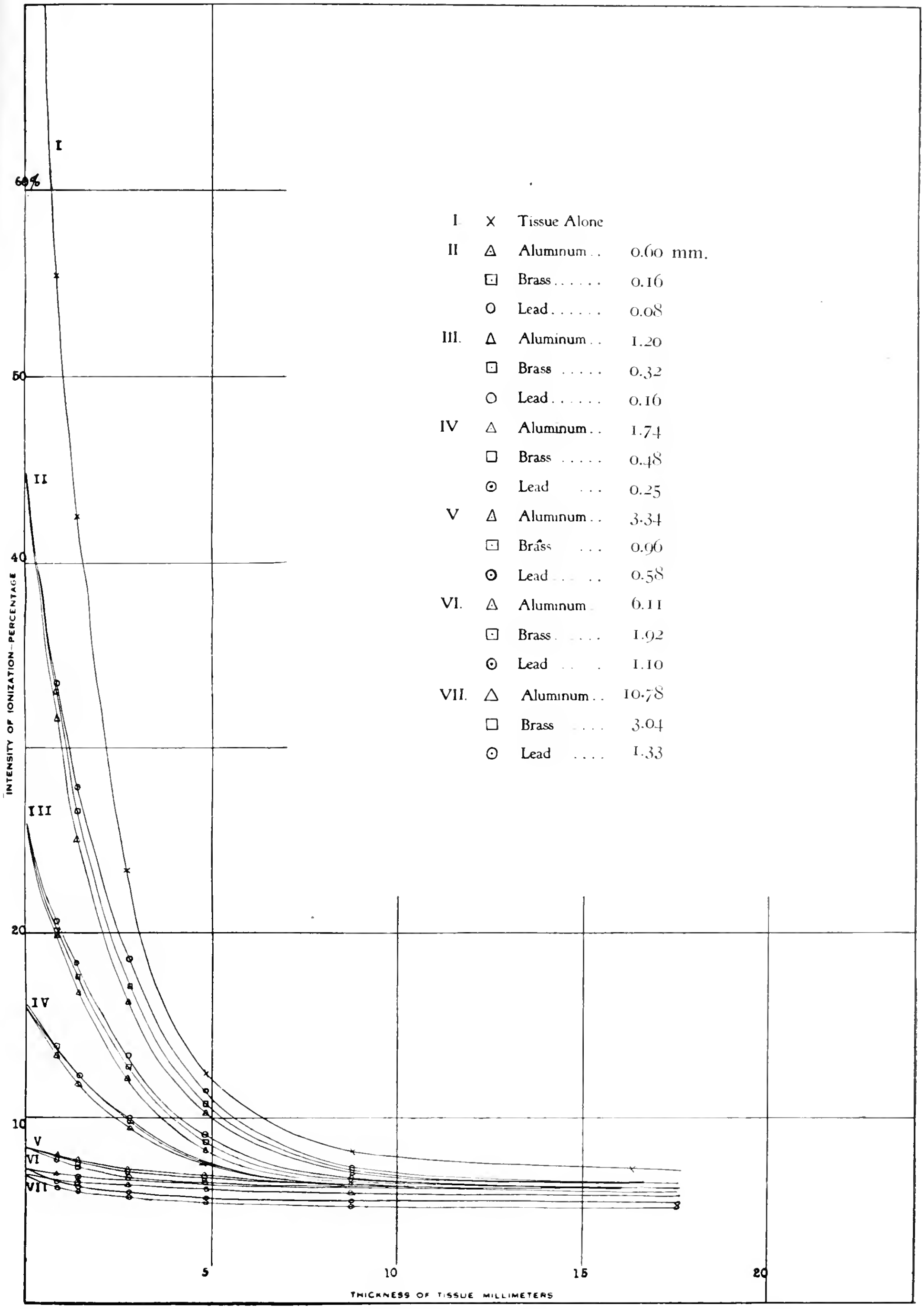


Fig. 4. Curves Showing Intensity of Ionization by Radiation Filtered Through Metals and Tissues.

To obtain the necessary penetrating radiation for deep therapy, in general a combination of filters is necessary. When substances of high atomic weight are used as filters, a considerable part of the emergent radiation is easily absorbed in tissue. Hence the necessity of a secondary filter of low atomic weight to remove this soft radiation. The analysis by tissue of the transmitted radiation enables us to determine what additional filtration is necessary when any metal is used as the primary filter.

For practical reasons brass is a good substance to use as a primary filter. Its secondary radiation is not very intense and can be removed to a sufficient extent by a few millimeters of rubber, which have the same effect as an equal thickness of tissue. A thickness of 2 millimeters of brass is sufficient for deep therapy.

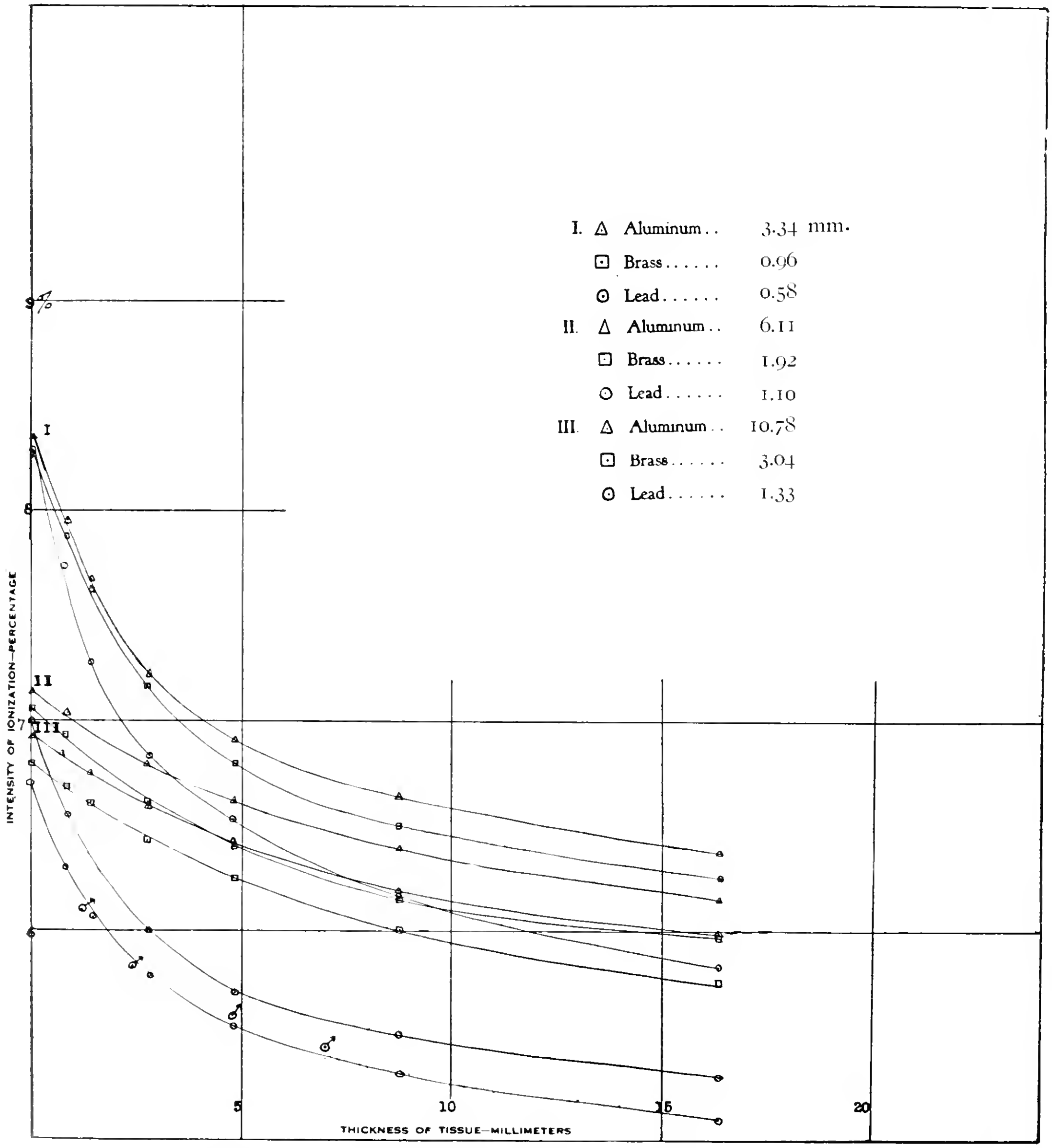


FIG. 5. CURVES SHOWING INTENSITY OF IONIZATION BY RADIATION FILTERED THROUGH METALS AND TISSUE.

The results obtained in these experiments are directly applicable to the treatment of patients, since the absorption by the tissue used is the same, within the limits of experimental error, as that by living tissue.

The writer wishes to express her thanks to Mr. Failla for suggesting this problem, and for his kind cooperation during the progress of the work.

TABLE I

PERCENTAGE OF IONIZATION PRODUCED BY RADIATION AFTER FILTRATION THROUGH METAL AND TISSUE

Filter		Millimeters of Tissue						
		0	0.82	1.40	2.77	4.84	8.74	16.35
Mica		100	55.4	42.5	23.5	12.4	8.24	7.18
0.60 mm	Al.	44.8	31.6	25.1	16.3	10.3	7.04	6.55
0.16	Br.	44.8	33.0	26.6	17.1	10.8	7.10	6.55
0.08	Pb.	44.8	33.0	27.0	18.6	11.6	7.15	6.50
1.20 mm	Al.	24.9	19.3	16.7	12.2	8.32	6.82	6.38
0.32	Br.	24.9	19.0	17.6	12.8	8.70	6.78	6.44
0.16	Pb.	24.9	20.2	18.4	13.4	9.10	6.80	6.32
1.74 mm	Al.	15.9	13.4	11.8	9.51	7.50	6.70	6.38
0.48	Br.	16.1	13.9	12.3	9.92	7.69	6.64	6.26
0.25	Pb.	15.9	13.7	12.2	10.1	7.73	6.55	5.83
3.34 mm	Al.	8.35	8.04	7.65	7.22	6.92	6.65	6.38
0.96	Br.	8.27	8.04	7.66	7.17	6.80	6.50	6.26
0.58	Pb.	8.27	7.76	7.28	6.83	6.56	6.18	5.83
6.11 mm	Al.	7.14	7.06	6.94	6.81	6.64	6.40	6.15
1.92	Br.	7.06	6.94	6.82	6.61	6.40	6.15	5.98
1.10	Pb.	7.00	6.55	6.35	6.00	5.70	5.51	5.30
10.78 mm	Al.	6.92	6.86	6.78	6.56	6.43	6.19	5.98
3.04	Br.	6.79	6.79	6.62	6.42	6.25	6.03	5.76
1.33	Pb.	6.70	6.30	6.03	5.78	5.54	5.32	5.10

BIBLIOGRAPHY

1. CROWTHER. On the Coefficient of Absorption of the Beta Rays from Uranium. *Phil. Mag.*, 1906, xii, 379.
2. SODDY, MR. AND MRS., and RUSSEL. The Question of the Homogeneity of the Gamma Rays. *Phil. Mag.*, 1910, xix, 725.
3. KOVARIK, A. F. Absorption and Reflection of Beta Particles by Matter. *Phil. Mag.*, 1910, xx, 849.
4. FLORANCE, D. C. H. Primary and Secondary Gamma Rays. *Phil Mag.*, 1910, xx, 921.
5. EVE, A. S. On the Secondary Radiation Caused by the Beta and Gamma Rays of Radium. *Phil. Mag.*, 1904, viii, 669.
6. GRAY, J. A. Scattering and Absorption of Gamma Rays of Radium. *Phil. Mag.*, 1913, xxvi, 611.

AN EXPERIMENTAL STUDY OF THE DURATION OF ARTIFICIAL PNEUMO-PERITONEUM*

By LEON T. LE WALD, M.D., F.A.C.P.

Professor of Roentgenology, New York University and Bellevue Hospital Medical College

NEW YORK CITY

In view of the extreme interest in the value of artificial pneumo-peritoneum for diagnostic purposes, it seems wise to settle a number of questions in regard to the procedure by means of experimental work on animals prior to making unlimited use of the procedure on human beings. Among the questions that have arisen are the following:

1. Minimum amount of gas.
2. Kind of gas.
3. Time that the gas remains in the peritoneal cavity.
4. Most suitable position in order to determine the nature of a particular lesion.

The following experiment was performed at the Edward N. Gibbs Memorial *X*-Ray Laboratory in conjunction with Prof. George B. Wallace, director of the Pharmacological Laboratory of New York University.

A male dog weighing 10 kilos was anesthetized by means of a solution of cholorotone in alcohol in the proportion of .4 gram chlorotone per kilo of body weight. The chlorotone was injected into the peritoneal cavity with a hypodermic syringe one hour prior to the injection of oxygen into the peritoneal cavity. The anesthetization was complete in twenty minutes. Complete anesthesia lasted for twenty-four hours. Oxygen was injected into the peritoneal cavity through a spinal puncture needle by means of displacement of water from one bottle to another. After 100 c.c. of oxygen had been injected a radiograph was taken in the postero-anterior position, prone. This showed good outlines of the abdominal viscera. Radiographs were then made after further injection up to 1,000 c.c., after which time the needle was withdrawn and a study made of the abdominal viscera in various positions of the body. (Fig. 1.)

Twenty-four hours later radiographs were made which showed an apparent diminution of oxygen in the peritoneal cavity. However, the information obtained was equal to that when the largest amount of oxygen was present.

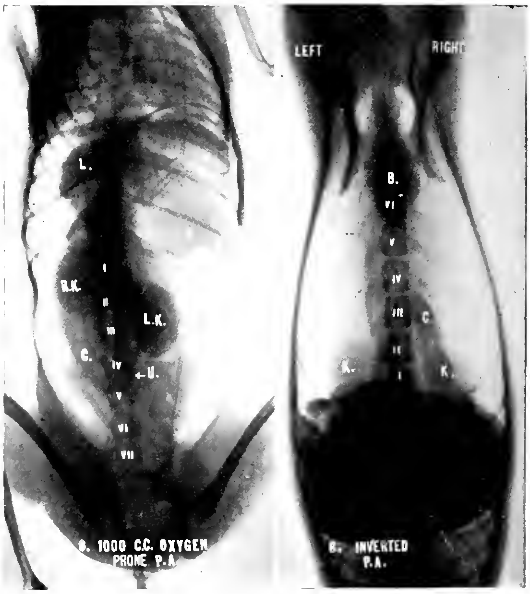


Fig. 1. Pure Oxygen; Immediately after Full Inflation. *Left Hand Figure:* Taken prone with plate under abdomen. Note detail in all but pelvic region. *Right Hand Figure:* Taken with pelvis elevated to vertical position with plate anterior. This gives extreme definition to the pelvic organs. Note the bladder outline.

At the end of forty-eight hours radiographs were again made and were of equal diagnostic value. (Fig. 2.) An increase in size of the urinary bladder was very evident when compared with the original and twenty-four hour exposures.

*Read before the Eastern Section of The American Roentgen Ray Society, Atlantic City, N. J., Jan. 31, 1920.

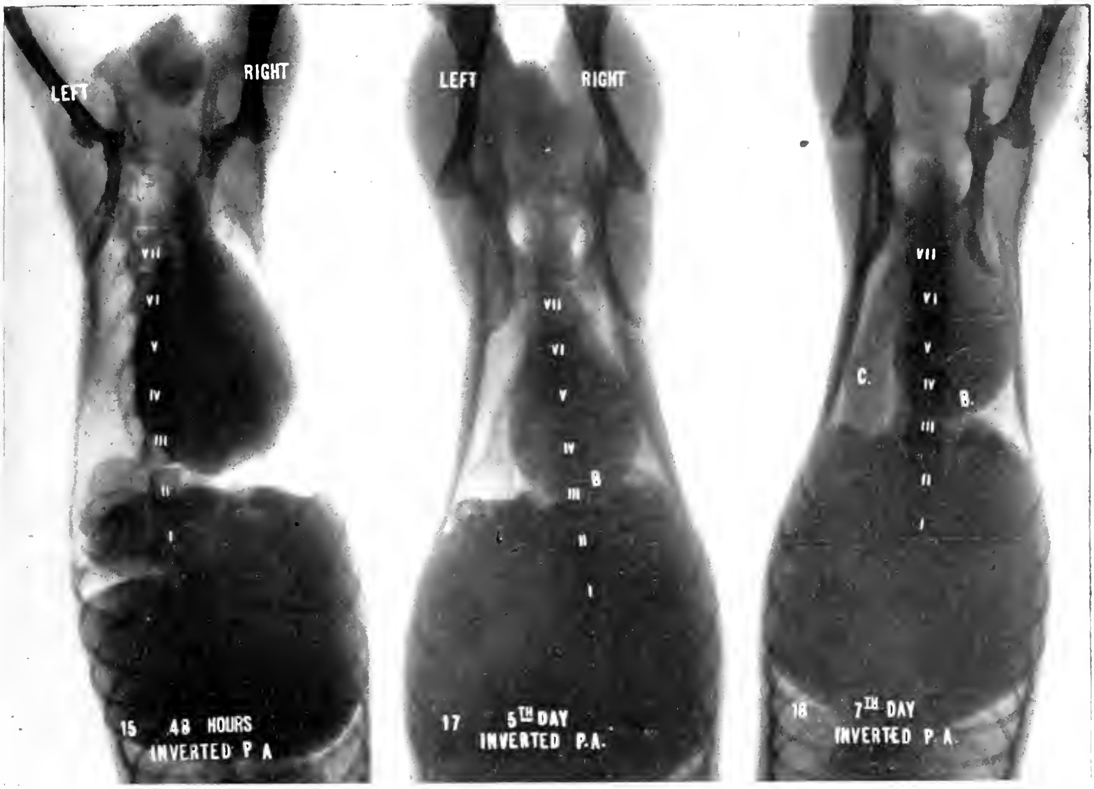


FIG. 2. PURE OXYGEN; RETENTION OF GAS FOR OVER A WEEK. *Left Hand Figure:* Taken at the end of the second day after injection shown in Figure 1. Note only *very slight* absorption has taken place. *Middle Figure:* Taken on the fifth day. *Right Hand Figure:* Taken on the seventh day, shows enough gas remaining to give diagnostic outline. In all three figures note the size of the bladder, indicating urinary retention and over-distention remaining even after the animal had recovered from the anesthetic.

On the third day exposures were again made which were of diagnostic value. They showed the bladder partly empty but retaining the effects of over-distention, as evidenced by its greatly elongated appearance. By this time the dog had recovered from the anesthesia.

Further exposures made on the 5th and 7th days were still of diagnostic value. (Fig. 2.)

On the twelfth day exposures showed that the gas had been so completely eliminated that the abdominal organs were not discernible.

CONCLUSIONS.

1. The presence of gas in the peritoneal cavity after the injection of oxygen can be demonstrated as late as eight days after the original injection.

2. A very moderate amount of gas is sufficient for diagnostic purposes. A proportion of about 2 c.c. of gas to 100 grams of body weight appears to answer this requirement.

3. The withdrawal of the gas appears advisable unless a rapidly absorbable gas, such as CO_2, is used.

4. The use of a more readily absorbable gas than oxygen appears desirable.

NOTE: Since this paper was read an effort has been made to follow the suggestion of Alvarez * and use carbon dioxide alone (Figs. 3 and 4) or a mixture of carbon dioxide and oxygen (Fig. 5). The results have demonstrated the very rapid absorption of carbon dioxide, and the retardation by means of mixing carbon dioxide and oxygen in suitable proportions.

* ALVAREZ, WALTER C. CO_2 Instead of O for Injecting the Peritoneal Cavity. *Calif. State J. M.*, Feb., 1920.

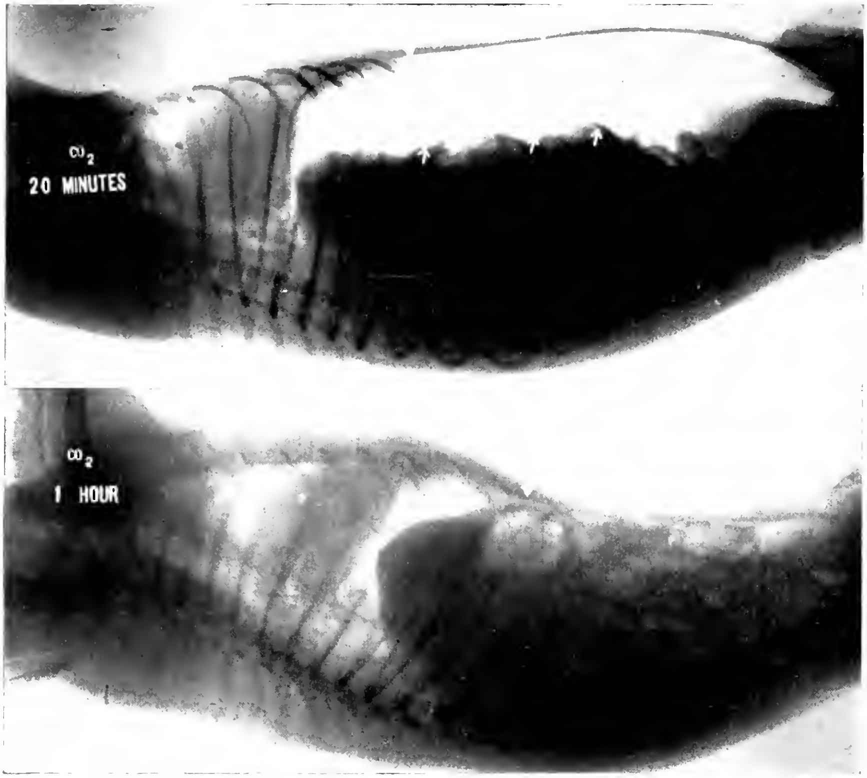


FIG. 3. PURE CARBON DIOXIDE.

Upper Figure: Taken in dorsal decubitus with the plate against the side. Note the abdominal contents have receded from the anterior abdominal wall, indicating the absence of any adhesions.

Lower Figure Taken Forty Minutes Later shows nearly all of the carbon dioxide has been absorbed. This offers a most striking contrast with the slow absorption noted in Figure 2 where oxygen was used.

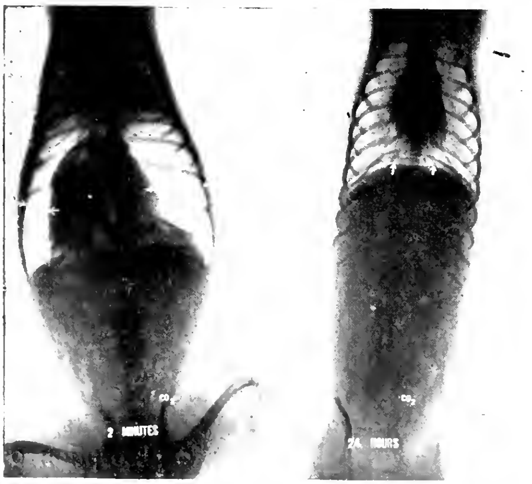


FIG. 4. PURE CARBON DIOXIDE, SHOWING FAINT TRACES OF GAS AT THE END OF TWENTY-FOUR HOURS (right hand figure). It is probable that this residual gas is not pure CO_2, but some other gases which have transfused during the absorption of the CO_2. Note, then, that in the case of CO_2, in spite of the fact that it is nearly all absorbed within the first hour, yet traces of this or some other gas can be detected as late as twenty-four hours.

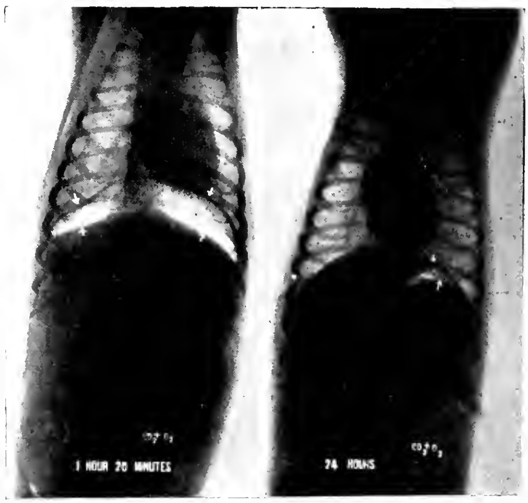


FIG. 5. MIXTURE OF CO_2 AND O. *Left Hand Figure* shows the retarding effect of oxygen on absorption. Compare with Figure 3, where absorption was almost complete at the end of one hour, while in this case a large amount of gas remains at the end of one hour and twenty minutes. Note in right hand figure a small amount of residual gas at the end of twenty-four hours.

THE VALUE OF THE ROENTGEN RAY IN THE STUDY OF DIVERTICULITIS OF THE COLON

THE RECOGNITION OF DIVERTICULITIS AS A CLINICAL ENTITY; CONSTIPATION AS AN ETIOLOGICAL FACTOR; PATHOLOGICAL CHANGES; SYMPTOMS; DIFFERENTIAL DIAGNOSIS; RADIOGRAPHIC CLASSIFICATION OF MULTIPLE DIVERTICULA; BIBLIOGRAPHY.

By ARIAL W. GEORGE, M.D. and RALPH D. LEONARD, A.B., M.D.

BOSTON, MASS.

[*Concluded from the September Issue*]

The various radiographic appearances of multiple diverticula roughly group themselves into three general classes. This radiographic classification corresponds with the grouping based on their pathology.

The *first class* is composed of cases showing simple diverticulum formation. The diverticula may be diffusely scattered throughout the colon. The patient may or may not have symptoms.

The *second group* consists of those cases showing beginning secondary inflammatory changes. These cases usually show the diverticula pretty well localized about the descending colon and sigmoid. The patients usually are having symptoms.

The *third group* consists of cases showing advanced secondary inflammatory changes, such as pericolitis, tumor, obstruction, etc. (Figs. 20-24).

GROUP I.—Occasionally in the course of the routine gastrointestinal examination, one will observe in the plate made twenty-four hours after the meal round discrete shadows of the same density as the barium-filled colon, but usually distinct from it. The shadows vary in size from that of a pinhead to a dime or larger. They are circular in outline and are in close proximity to the intestinal wall. Under the fluoroscopic screen they seem to be a part of or intimately connected with the wall, yet distinctly outside the lumen of the intestine.

These shadows represent the barium-filled diverticula. They may be seen anywhere throughout the entire colon from the cecum to the rectum. Any portion of the circumference of the gut may be affected. As these diverticula have a tendency to retain the barium, as mentioned before, the best time to observe them is thirty-six to forty-eight hours after the meal, at which time the lumen of the intestine is free of the barium and the round discrete shadows of the barium in the diverticula stand out clearly.

FIG. 20. DIVERTICULA WITH ADVANCED INFLAMMATORY CHANGES. Plates taken following the barium enema. Infiltration of intestinal wall from *A* to *B*. One large diverticulum at *C*. Symptoms of obstruction. Operation showed a chronic inflammatory mass. Class III.

These shadows, varying in number, may be seen anywhere along the course of the colon, the most likely site being the descend-

ing colon and sigmoid. In some of the extreme cases the diverticula appear very much like a string of beads.

The diverticula classified in this first group are frequently not associated with

Fig. 21. A Small Area of Inflammatory Changes of the Bowel, at time of operation considered to be carcinoma. After study of microscopic section, it was decided not to be malignant and for that reason was placed in this classification.

symptoms. They are occasionally found during a routine examination in people apparently well.

As the condition is one of a simple diverticulum formation without inflammatory changes, about the only symptoms to be expected would be those of toxic absorption, the absorption being from the prolonged stasis of fecal material in the diverticula.

Two conditions may present radiographic pictures likely to be confused with simple diverticula. *First,* a hypertonic condition of the colon may be associated with almost a spastic condition of the haustra, so that discrete masses of barium become separated from the mass of barium in the lumen. The dependent portions of the haustra of the transverse colon seem to be a common location. The plates made at intervals will demonstrate that these apparent sacculations are only temporary. A true diverticulum is permanent. Again, study with the fluoroscope and barium enema will show that these haustral shadows are within the lumen of the gut and are not extramural, as is the case with the diverticulum.

Second, in a certain type of individuals the colon contents become subdivided into small discrete masses, particularly in the descending colon and sigmoid. A spastic type of constipation frequently produces this condition. These small masses may be confused with diverticula. The inconstancy of these shadows is the chief means of differentiation.

Group 2.—The second group in the classification of diverticulitis is composed of cases showing beginning secondary changes of an inflammatory nature. The diverticula in this group are usually localized along the lower descending colon and sigmoid. The patients invariably have more or less definite symptoms.

The *x*-ray plate shows numerous diverticula ranging from four or five to twenty, situated in a limited region about the junction

Fig. 22. Multiple Diverticula with Chronic Inflammatory Changes. Plate taken after a barium enema. Narrowing of intestine from *A* to *B*. Operation showed tumor mass composed of chronic inflammatory tissue. Class III.

of the sigmoid and descending colon (Figs. 13-19).

The amount of intestine involved is not more than two or three inches. The important radiographic appearance differentiating this from the preceding group is a beginning narrowing of the lumen of the intestine. The apparent narrowing may at first be wholly due to spasm. It is usually best observed following the barium meal. Frequently the enema fails to reveal this spastic condition. In later cases, where there is actual thickening about the colon wall, the narrowing is constant both with the meal and enema.

Under the fluoroscopic screen there is usually found localized tenderness. The sigmoid may be fixed from inflammatory adhesions. The infiltration of chronic inflammatory tissue in and about the intestinal wall will produce a demonstrable rigidity of the wall.

Fig. 24. Chronic Inflammatory Changes About the Descending Colon and Sigmoid. Plate taken after a barium enema. The "serrated" appearance is more marked than in the previous illustration. The individual diverticula are not seen. Class III.

Fig. 23. Chronic Inflammatory Changes Involving Descending Colon and Sigmoid. No diverticula are seen, but the intestine presents a serrated appearance such as is found associated with diverticulitis. Class III.

The condition which it is important to differentiate from cases in this group and the third group is *carcinoma*. I do not believe that a positive differentiation can always be made with the *x*-rays alone, particularly as a certain number of cases have malignant disease developing on top of a chronic diverticulitis. The history and physical examination as well as the laboratory findings are of the utmost importance in making this differentiation. In studying the *x*-ray plates there are one or two points which one must bear in mind when considering the possibility of cancer or diverticulitis.

In the first place, the *x*-ray appearance of diverticulitis tends to remain constant even over long periods of time. If malignant disease is present, repeated examinations show a progressing lesion. If in a continued study of a diverticulitis case we find a portion of the involved area beginning to change its contour, one must be suspicious of a beginning malignancy.

Cancer, in general, is an intra-intestinal growth. The growth is in the wall of the colon, extending into the lumen and definitely circumscribed. The tumor mass in diverticulitis is outside the intestinal wall, being a pericolitis or perisigmoiditis. It is not definitely circumscribed.

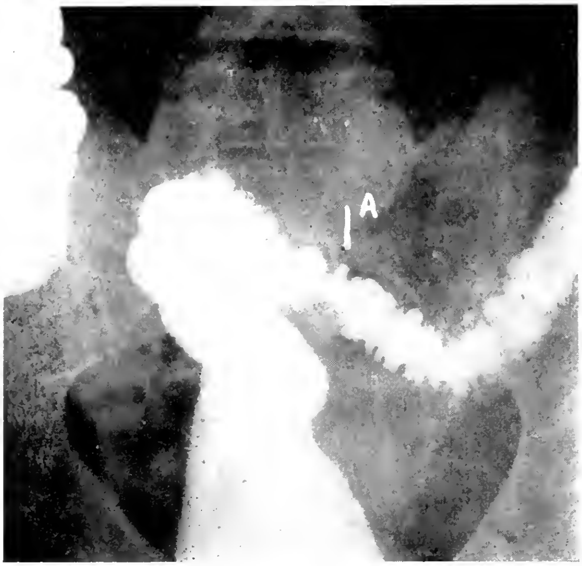


FIG. 25. SAME CASE AS FIG. 24, SHOWING CONSTRICTION AT POINT *A*. Operation showed this to be chronic inflammatory tissue.

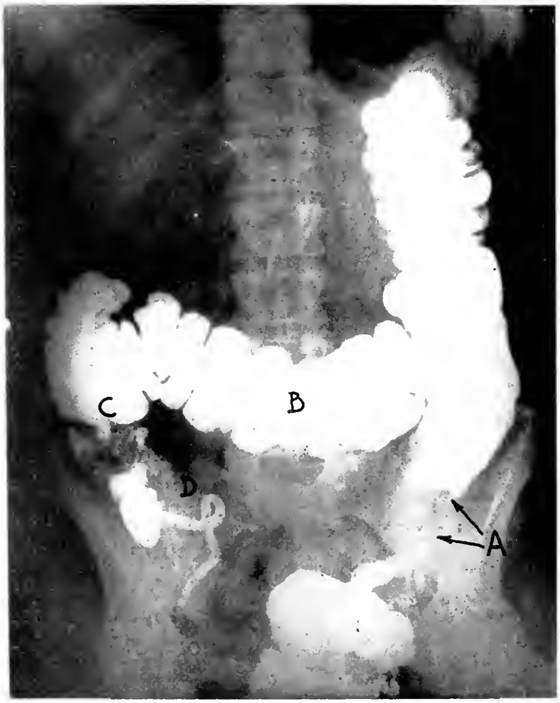


FIG. 26. CANCER OF THE COLON AT POINT *A*; *B*, TRANSVERSE COLON; *C*, HEPATIC FLEXURE; *D*, APPENDIX. Plate taken after barium enema. Note the abrupt transition from normal bowel to diseased bowel, which is characteristic of growth. In Figure 25 note that the transition from normal to diseased bowel is gradual. This is characteristic of chronic inflammation.

Hence when we find a filling defect in the colon producing a narrowing of the lumen, with the transition from normal bowel to diseased bowel, immediately we suspect cancer. With a narrowing due to diverticulitis several inches of colon on either side of the actual point of narrowing will show more or less evidence of disease. In other words, in diverticulitis the transition from normal bowel to diseased bowel is *gradual,* while in cancer the transition is abrupt (Figs. 20-26).

Obstruction from cancer is likely to be severe, rapidly progressive, and finally complete. Obstruction from chronic diverticulitis is usually not severe, with very gradual progress extending sometimes over a period of years, and rarely complete (Figs. 25 and 27).

Under the fluoroscopic screen an intermittent palpable tumor of the colon is always peridiverticulitis. A constant and persistent tumor mass may be cancer.

GROUP 3.—In the third group we put the cases showing advanced secondary changes associated with moderate to severe symptoms. In this group are the various forms of obstruction. The tendency in any chronic inflammatory mass is to contract. As we find a chronic obstruction following an indurated ulcer at the pylorus of the stomach, so with the inflammatory condition about the colon the same process takes place. The tendency in chronic diverticulitis is toward chronic obstruction, possibly extending over years.

The *x*-ray picture of colon obstruction is characteristic and needs no special comment. There is stasis proximal to the point of obstruction with possible dilatation of this portion of the intestine. This is studied best following the barium meal. Plates should be taken at sufficient intervals to determine the degree of obstruction—forty-eight or seventy-two hours after the meal, if necessary. The barium enema will confirm the meal and also give more detailed evidence as to the amount of colon involved and the degree of narrowing.

In this connection one must mention an

appearance of the colon which has become to our mind almost pathognomonic of chronic diverticulitis, although the diverticula themselves are not visualized. Particularly along the descending colon and sigmoid one occasionally finds a peculiar serrated appearance of the colon (Fig. 23). This may extend over several inches of the gut and is associated with more or less narrowing of the lumen. These serrations are small, close together, and with a rather sharp point, presenting at times a saw-tooth appearance. They will not be confused with haustral shadows, for they are too numerous and too small, and, more important, they are constant in shape and position.

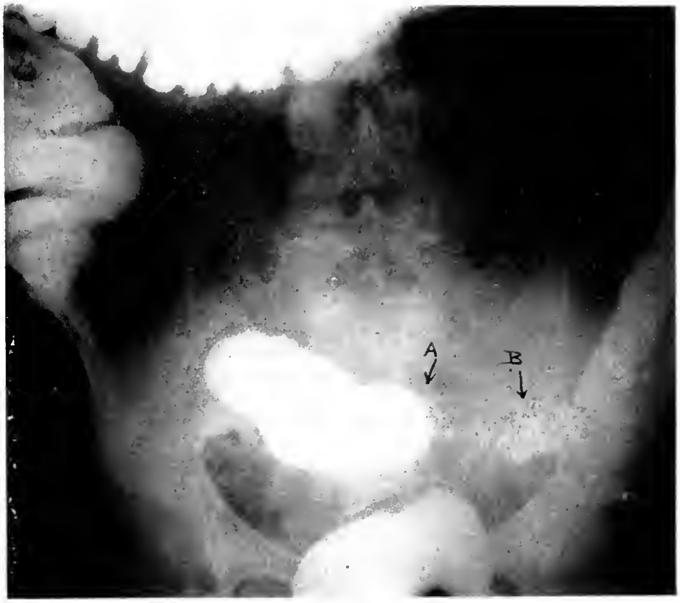


Fig. 27. Chronic Obstruction from Diverticulitis. Lesion at points *A* and *B*.

This serrated appearance is best seen following the enema, although it may be observed in the twenty-four hour plate after the meal. Repeated enemata given on different days show this appearance to be constant.

Fig. 28. Same Case as Figure 27, four years later, showing complete obstruction to barium enema. Operation revealed chronic inflammatory mass.

The serrations do not change in size or shape. Furthermore, palpation under the fluoroscopic screen usually shows us that the intestine is more or less like a rigid tube. The walls are thickened and have lost their normal flexibility.

One infers that the serrated appearance is due to inflammatory thickening and induration in and about the intestinal wall, secondary to the presence of diverticula. The diverticula themselves not being visible, perhaps obliterated by the connective-tissue formation, are already so filled with mucus and fecal material that the barium is unable to enter.

There are other complications secondary to diverticulitis besides simple obstruction. Adhesions arising from the localized diverticulitis may involve other coils of intestines or other organs. Such a condition is best observed under the fluoroscopic screen.

Chronic perforation with abscess formation is not an uncommon sequel. The *x*-ray appearance is no different from a chronic perforation of gastric or duodenal ulcer. The plate may show an abscess cavity filled with barium outside the lumen of the gut, with a small isthmus of barium connecting it with the intestine. Acute perforations do not come to the *x*-ray man.

Some of the acute diverticulitis attacks simulate a left-sided appendix. The barium enema may be of help in such cases by demonstrating that the cecum and appen-

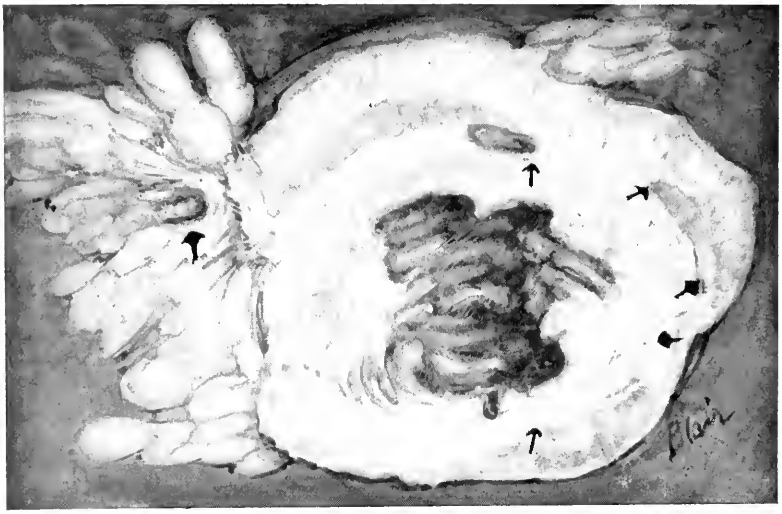


Fig. 29. Drawing of Specimen Taken from the Preceding Case. Shows cross section of sigmoid, the wall of which is enormously thickened by chronic inflammatory tissue. Within the mass are seen the diverticula, to which the arrows are pointing. No evidence of malignancy.

Fig. 30. Shows Mild Degree of Diverticulitis, with Several Diverticula.

dix are in normal position on the right side.

Rarely fistulae may result from diverticulitis. Several cases have been reported of fistulae connecting the bladder with the colon. Such conditions would be clearly shown on the x-ray plate.

In general, it must be borne in mind that the diagnosis of multiple diverticulitis is not to be made from the x-ray alone, although in some cases it may seem possible. The x-ray evidence must be considered in conjunction with the history, physical examination, and other laboratory findings. This is of particular importance in the differentiation of cancer and multiple diverticulitis.

BIBLIOGRAPHY

Abbe, Robert. A Case of Sigmoid Diverticulitis. *Med. Rec.*, 1914, lxxxvi, 190-191.

Abbott. *J. Minn. M. Assn.*, 1910, xxx, 118, 119.

Ashhurst, A. P. C. Sigmoid Diverticulitis in a Child. *Ann. Surg.*, 1908, xlvii, 300-305.

Ball, Sir Charles. The Rectum; Its Diseases and Developmental Defects. 1908.

Barbat. Diverticulitis of the Sigmoid. *Surg., Gynec. & Obst.*, 1910, x, 295-299.

Beer. *Am. J. M. Sc.*, 1904, cxxviii, 135.

Bergman, Bruns and Nuculicz. Handbuch d. prakt. Chir. Eng. trans., System of Pract. Surgery, by Bull and others, 23 A, 400, iv, 252.

Blakeway. Two Specimens Illustrating Diverticulitis of the Large Intestine. *Proc. Roy. Soc. Med. (Sec. Surg.)*, 1913-14, vii, 253.

Bland-Sutton. Pericolitis. *Med. Press & Circ.*, 1915, xc, 412.

Bochin and Dean. Sigmoidovesical Fistula. *Amer. J. Urol.*, 1912, viii, 474-482.

Bodkin. Sigmoiditis. *Med. Rec.*, 1908, lxxiv, 403, 404.

Brewer. Etiology of Certain Cases of Left-Sided Intra-Abdominal Suppuration. *J. Am. M. Assn.*, 1907, 482; Acute Diverticulitis of the Sigmoid, with Operation before Rupture. *Ibid*, 1908, 543.

Bristowe. *Tr. Am. Surg. Assn.*, 1908, xxvi, 360; also *Tr. Path. Soc.*, vi, 191.

Bruce, H. A. Inflammatory Tumors of the Abdomen. *Surg., Gynec. & Obst.*, 1911, xiii, 102; Acute Diverticulitis. *Ann. Surg.*, liv, 682.

Bryan, R. C. Sigmoidovesical Fistula. *Ann. Surg.*, 1916, lxiii, 352-361.

Cameron and Rippman. Five Cases in which Acquired Diverticula of the Sigmoid Resulted in Death. *Guy's Hosp. Rep.*, 1910, lxiv, 373.

Carman. Roentgenologic Findings in Cases of Diver-

ticulitis of the Large Bowel. *Ann. Surg.*, 1915, lxi, 343.

CARMAN. Diverticulitis of Sigmoid. AM. J. ROENTGENOL., February, 1915.

CARNARDINE. Pericolitis. *Bristol M. Chir. J.*, 1913, xxxi, 333.

CASE. Roentgenologic Demonstration of Multiple Diverticula of the Sigmoid. AM. J. ROENTGENOL., 1915, ii, 654.

CHUTE, A. L. Two Cases of Vesico-intestinal Fistula Due to Diverticulitis of the Sigmoid. *Tr. Am. Assn. Genito-Urin. Surg.*, 1911, vi, 86.

CONDIT. Multiple Diverticula of the Colon. *Med. Rec.*, 1902, lxii, 236.

DONALDSON. Pericolitis Sinistra with Abscess Formation. *Brit. M. J.*, 1907, ii, 1705.

DOUGLAS, J. Diverticulitis of the Sigmoid. *Ann. Surg.*, 1913, lxiii, 356-364, 1 plate.

DUNN, A. D. Diverticulitis of the Sigmoid. *Proctologist*, vii, 66-72.

DUNN and WOOLEY. Acquired Diverticulitis of the Sigmoid, with a report of 6 cases. *J. Am. M. Assn.*, 1911, cxlii, 22.

EASTMAN and COLE. Pericolitis Sinistra. *Ann. Surg.*, 1914, lix, 41.

EISENDRATH. Sigmoid Diverticulitis. *Arch. Diagn.*, 1909, ii, 368.

ERDMANN. Diverticulitis of the Colon. *N. York M. J.*, 1914, xcix, 509.

ERDMANN, J. F. Acute Diverticulitis of the Colon. *Surg., Gynec. & Obst.*, 1918, xxvi, 207-211, 1 figure.

FISCHER. *J. Exper. M.*, 1901, v, 333.

GIFFIN, H. Z. The Diagnosis of Diverticulitis. *J. Am. M. Assn.*, 1912, l, 864-866.

GIFFIN, H. Z. Diverticulitis in the Rectum. *Ann. Surg.*, April, 1911.

GIFFIN and WILSON. A Case of Carcinoma on Diverticulitis of the Sigmoid. *Am. J. M. Sc.*, 1909, cxxxviii, 661, 666; Diverticulitis of the Colon. *Ann. Surg.*, 1911, liii, 533.

GARDINIER and SAMPSON. Diverticulitis Causing Intestinal Obstruction. *J. Am. M. Assn.*, 1906, l, 1585.

GRAVES. *Boston M. & Surg. J.*, March 16, 1911.

HAMILTON, DRUMMOND. Sacculi of the Large Intestine, with Special Reference to their Relations to the Blood-vessels of the Bowel Wall. *Brit. J. Surg.*, iv, 407.

HARRIGAN, A. H. Diverticulitis of the Sigmoid. *Med. Rec.*, 1913, lxxxiv, 1099.

HARTWELL. Diverticulitis of the Sigmoid. *Ann. Surg.*, 1910, li, 584; Perforation of a Diverticulum of the Ascending Colon. *Ibid*, 1910, 269.

HARTWELL and CECIL. Intestinal Diverticula. *Am. J. M. Sc.*, 1910, cxl, 174-203.

HAUSEMAN. *Virchow's Arch. f. path. Anat.*, cxliv.

HEDINGER. Some Colonic, Sigmoid, and Rectal Conditions. *Arch f. Path. Anat.*, 1904, clxxviii, 25-43.

JACKSON. Membranous Pericolitis. *Surg., Gynec. & Obst.*, 1909, ix, 278-284.

JONES, GLUM J. Colonic and Pericolonic Abnormalities. *Am. J. M. Sc.*, 1915, cxlix, 388.

KIRBY, L. Diseased Conditions and Treatment. *J. Arkansas M. Soc.*, 1917, xiv, 122.

LEJARS, F. Chronic Universal Diverticulitis. *Surg., Gynec. & Obst.*, 1911, xiii, 466.

LILIENTHAL, H. Perforating Diverticulitis of the Sigmoid. *Ann. Surg.*, 1910, lii, 558-560.

LITHY. Diverticulitis. *J. Iowa State M. Soc.*, October, 1911.

LITTLEWOOD. Case Reports. *Lancet*, 1909, ii, 1352; 1910, i, 1340.

LONG. Acquired Diverticulum of the Sigmoid Flexure. *Long Island M. J.*, 1911, v, 416.

MAYHEW. Intestinal Diverticulitis. *Colorado Med.*, 1913, x, 147.

MAYO, CHARLES H. Diverticula of the Gastro-intestinal Tract. *J. Am. M. Assn.*, lix, 260-264.

MAYO, W. J. Diverticulitis of the Large Intestine. *J. Am. M. Assn.*, 1917, lxix, 181-185; Diverticula of the Gastro-intestinal Tract. *Ibid*, 1912, lxix, 260.

MAYO, W. J., WILSON, L. B., and GIFFIN, H. Z. Acquired Diverticulitis, etc. *Surg., Gynec. & Obst.*, 1907, viii, 15.

MCCONNELL, G. Acquired Intestinal Diverticula. *J. Am. M. Assn.*, 1910, liv, 205-207.

MCGRATH, B. F. Intestinal Diverticula; Etiology and Pathology. *Surg., Gynec. & Obst.*, 1912, xv, 429-444.

MCWILLIAMS, C. A. Acute Diverticulitis of Descending Colon and Sigmoid Perforation. *Ann. Surg.*, 1908, xlvii, 132-134.

MILES. Surgical Diseases of the Sigmoid. *N. York M. J.*, 1904.

MILLER. Acquired Diverticula of the Large Intestine. *N. Orl. M. & S. J.*, 1909-10, lxiii.

MONSARRAT. On the Simulation of Malignant Disease by Chronic Inflammatory Affections of the Sigmoid. *Brit. M. J.*, 1907, ii, 65.

MORLEY. Acute Perforating Diverticulitis of the Pelvic Colon. *Med. Chron.*, 1913-14, xxvi, 469.

MOSCHOWITZ. Perforating Sigmoiditis. *Ann. Surg.*, 1910, 712.

MURPHY. Peridiverticulitis. *Clin. of John Murphy*, Chicago, 1916, 31.

MURRAY, R. W. Diverticula of the Large Intestine. *Med. Chir. J., Liverpool*, 1913, xxxiii, 136-139; *Med. Press & Circ.*, 1913, n.s., xcvi, 320.

OLDFIELD, C. Diverticulitis as a Cause of Pelvic Inflammation, with a Short Account of Three Cases. *J. Obst. & Gynaec. Brit. Emp.*, 1913, xxiii, 43-48, 1 plate.

PIPLE. Case of Diverticulitis of the Sigmoid. *South M. & S. J.*, 1910 xiv, 131.

POWERS. Acquired Diverticulitis of the Sigmoid Flexure of the Colon. *Tr. Am. Surg. Assn.*, 1912, xxv, 149; also in *Ann. Surg.*, 1912, lvi, 118; *J. Am. M. Assn.*, 1912, lix, 301.

RANSOHOFF. Acute Perforating Sigmoiditis in Children. *Ann. Surg.*, 1913, lviii, 218.

RIXFORD. Acute Diverticulitis. *Tr. Am. Surg. Assn.*, 1908, xxvi, 360.

ROBERTS, D. Diverticula, Recognition and Treatment. *Surg., Gynec. & Obst.*, 1918, xxvi, 211-217.

ROBERTS, J. E. H. Specimens from a Case of Diverticulitis of the Large Intestine. *Proc. Roy. Soc. Med., (Sec. Surg.)*, 1913-14, vii, 253.

ROLLESTON. Pericolitis Sinistra. *Lancet*, 1915, i, 854.

ROWLANDS. Diverticulitis of the Colon. *Guy's Hosp. Gaz.*, 1911, xxv, 326; Sigmoiditis and Mesosigmoiditis. *Lancet*, 1910, i, 1194.

ROYSTER. Adhesions of the Sigmoid Causing Pelvic

Symptoms. Tr. Soc. Surg. & Gyn. Assn., December 17, 1912.

SHOEMAKER. Obstructive Pelvic Lesions Associated with Chronic Diverticulitis. *Ann. Surg.*, 1914, lix, 422.

STANTON, J. Diverticulitis. *Boston M. & S. J.*, 1913, clxviii, 343-346.

STARELEY. Case of Peridiverticulitis. *Wash. M. Ann.*, May 14, 1915, 3.

ST. CLAIR, W. H. Acute Diverticulitis, Acquired. *West Virginia M. J.*, 1917, xii, 88.

TELLING. Acquired Diverticula of the Sigmoid Flexure, illustrated. *Lancet*, 1908, i, 843-850, 928-931.

TELLING and GRUNER. Diverticulum, Diverticulitis and Peridiverticulitis. *Brit. J. Surg.*, 1911, iv, 468-530.

TUTTLE. Sigmoiditis and Perisigmoiditis. *Am. J. Surg.*, April, 1909; Sigmoid Diverticulitis. *Arch. Diagn.*, October, 1909.

VICK. Notes on a Case of Diverticulitis of the Pelvic Colon. *Proc. Roy. Soc. Med.*, 1913-14, vii, pt. 3, 252.

VIRCHOW. *Virchow's Arch.*, v, 1853.

WESTBROOK. Diverticulitis of the Colon. *Long Island M. J.*, 1914, 414.

ZACHARIE. A Case of Acute Diverticulitis Mistaken for Appendicitis. *N. York Stat eJ. M.*, 1908, viii, 308.

ANSCHUTZ. Ueber erworbene falsche Divertikal des Dickdarms u. Beitr. zur Behandlungen von Darmsfisteln. *Ztschr. f. Chir.*, 1909, xxxiv, 1176.

ARNSPERGE. Ueber entzündliche Tumoren der Flexura sigmoidea. *Mitt. a. d. Grenzgeb. d. Med. u. Chir.*, 1910, xxi, 557.

BERARD. Quelques Types de Sigmoïdite. *Lyon méd.*, 1911, 964.

BITTORF. Die akuten u. chronischen unschriebenen Entzundungen des Dickdarms. *München med. Wchnschr.*, 1904, 147.

BREHM, O. Ueber d. mesenterisalchrumphung u. ihre Beziehungen zum Volvulus d. Flex. sigm. *Arch f. klin. Chir.*, 1903, vii, 266-301.

CATZ. Sigmoïditis et perisigmoïditis. *Gaz. d. hôp.*, 1907, 15.

CHAVANNEZ. Des Fistules Vesico-intestinales acquises chez d'hommes. *Ann. med. org. gen. urin.*, 1897, xv, 1176, 1287,; 1898, January and February.

CHIARI. Ueber d. Folgen d. Dickdarmdivert, u. ihre Bez. z. d. Analstein. *Wein. med. Jahrb.*, 1878.

CIGNOZZI. Meso e perisigmoiditis fibrosa adhesica. *Riforma Med.*, 1910.

DELBET. Fistule intestino vesicale. *Bull. et mém. soc. d. chir.*, 1903, xxix, 317.

DELORME ET LAMBEAT. Sigmoïditis et Cancer. *Lyon Chirurg.*, 1911, v, 150.

DERE. Divert. mulp. de colon. *Rev. méd. de Normandie*, 1909, 167.

DUCHAMP. Diverticule intestinale; son ablation dans le cours d'une appendicectomia. *Loire méd.*, 1910, xxix, 204.

EBNER. Torsion eines Fettanhängen u. multiple Darmdivertikel. *Deutsche Ztschr. f. Chir.*, 1909, xcviii, 311.

EDEL. Ueber erworbene Darmdivertikel. *Virchow's Arch.*, 1904, cxxxviii, 347-364.

EIBEGGAR. Ueber eine Flexurstenose. *Prag. med. Wchschr.*, 1910, xliii, 536.

EISENBERG. Uber die von erworbenen Divertikelen. *Beitr. z. klin. Chir.*, 1914, lxxxiii, 627-638.

FRANKE. Path. u. Ther. der falschen Divertikel u. Dickdarm. *Deutsche med. Wchschr.*, 1909, xxxv, 98.

GANGOPHE. Sigmoïdite et Cancer. *Lyon chirurg.*, 1911, 121.

GEORGI. Ueber das erworbene Darmdivertikel. *Deutsche Ztschr. f. Chir.*, 1903, lxvii, 321.

GRASER. Ueber multiple falsche Divertikel. *München. med. Wchschr.*, 1899, xii, 721.

GRAWITZ. Ueber d. Bildungsmechanismus eines grossen Dickdarmdivertikels. *Virchow's Arch.*, 1876, 68.

NEUPERT. Zm. Path. d. Darmdivertikel. *Arch. f. klin. Chir.*, 1908, lxxxvii, 953; lxxxix, 399.

PATEL. Sigmoïditis Perforantes (Diverticulitis). *Lyon chirurg.*, 1911, vi, 121-143.

STIERLIN. Clinical Significance of Acquired Diverticulitis of Intestine. Corresp. d. schweizer Arzte, 1902, xxxii, 749.

SUDECK. Zur Frage der Diverticulitis u. Sigmoiditis. *Beitr. z. klin. Chir.*, 1914, xciv, 80.

THE AMERICAN JOURNAL OF ROENTGENOLOGY

PUBLISHED BY PAUL B. HOEBER, NEW YORK CITY

Issued Monthly. Subscription, $6.00 per year. Advertising rates submitted on application. Editorial office, 480 Park Av., New York. Office of publication, 67-69 East 59th St., New York.

TWENTY-FIRST ANNUAL MEETING OF THE AMERICAN ROENTGEN RAY SOCIETY

THE AMERICAN ROENTGEN RAY SOCIETY'S Twenty-first Annual Meeting has passed into history as one which has sustained the traditions of the Society. That the scientific effort of the Society has advanced with that of general medicine is indicated by the papers, as well as by the scientific exhibit. The attendance was large, almost 700 having registered. The commercial exhibit was the largest and most diversified that we have ever had, including exhibits of radium as well as of every conceivable device of use to the radiologist. Some of the new apparatus showed much study, and is a decided improvement on the older standards.

The following program was carried out:

PROGRAM

MAYO CLINIC, ROCHESTER, MINN.

Tuesday Morning, September 14, 1920.

8 A. M. to 12 noon. Surgical Clinics.

St. Mary's Hospital:
- Operating Room 1.—Dr. C. H. Mayo.
- Operating Room 2.—Dr. W. J. Mayo.
- Operating Room 3.—Drs. E. S. Judd and V. C. Hunt.
- Operating Room 4.—Drs. D. C. Balfour and J. C. Masson.
- Operating Room 5.—Drs. W. E. Sistrunk and C. A. Hedblom.
- Operating Room 6.—Drs. J. D. Pemberton and A. W. Adson.

Colonial Hospital:
- Orthopedic surgery.—Drs. M. S. Henderson and H. W. Meyerding.
- Thoracic surgery.—Dr. C. A. Hedblom.

Worrell Hospital:
- Oral surgery.—Dr. G. B. New.
- Surgery of Ear, Nose and Throat.—Drs. H. I. Lillie and R. A. Barlow.
- Dental surgery.—Drs. B. S. Bardner and L. T. Austin.

9 A. M. to 11 A. M.

St. Mary's Hospital:
- Pathological demonstration.—Dr. William C. MacCarty.
- Demonstration of Gross Pathology.—Dr. H. E. Robertson.

Radium Hospital:
Radium and Roentgen Therapy Clinic.—Dr. H. H. Bowing.

Tuesday Afternoon at 2 P. M.

ADDRESS OF WELCOME: *The Relation of Roentgenology to Surgery;* by Dr. William J. Mayo.

Roentgenology in Bone Diseases: Dr. M. S. Henderson.

Pyeloroentgenography: Dr. W.F.Braasch.

Roentgenology in the Mayo Clinic: Dr. R. D. Carman.

A Comparison of Roentgenologic and Pathologic Findings in Gastro-Intestinal Lesions: Dr. W. C. MacCarty.

Radiumtherapy in the Mayo Clinic: Dr. H. H. Bowing.

Roentgenology in Dental Diseases: Dr. B. S. Gardner.

Graduate Education in Roentgenology: Dr. L. B. Wilson.

HOTEL CURTIS, MINNEAPOLIS, MINN.

Wednesday Morning, September 15, 9 A.M.

WELCOME: By the Local Committee; Dr. J. Frank Corbett, Minneapolis, Minn., Chairman.

RESPONSE: By Dr. James T. Case, Battle Creek, Mich., President.

Intra-Cranial Calcifications with a Case Report: Dr. John T. Murphy, Toledo, Ohio.

The Bucky Principle as Applied to Roentgenography of the Spine: Dr. Hollis E. Potter, Chicago, Illinois.

Studies on the Reduction of Bone Density: Dr. Dallas B. Phemister, Chicago, Illinois (by invitation).

A Retinometer, an Instrument for Measuring the Degree of Sensitiveness to Light of the Retina to be Used in Connection with Fluoroscopy: A. W. Pirie, Montreal, Quebec, Canada.

An Instrument for Comparing the Efficiency of Fluorescent Screens and the Fluoroscopic Vision of Individuals: Dr. David R. Bowen, Philadelphia, Pa.

An Attachment for Multiple Exposures with the Upright Fluoroscope: Dr. David R. Bowen, Philadelphia, Pa.

Leather-Bottle Stomach: Linitis Plastica: Dr. L. T. LeWald, New York City.

Wednesday Afternoon at 1:45 P. M.

Observations on the Behavior of the Normal Pyloric Sphincter in Man: Dr. C. W. McClure and Dr. Lawrence Reynolds, Boston, Mass. (By invitation.)

Roentgen Diagnosis in Diseases of the Heart: Dr. Gonzales Martinez of Paris, France, and Porto Rico. (By invitation.)

New Roentgenographic Technique for the Study of the Thyroid: Dr. George E. Pfahler, Philadelphia, Pa.

Roentgenographic Studies of Bronchiectasis and Lung Abscess After the Direct Injection of Bismuth Solution Through the Bronchoscope: Dr. H. L. Lynah and Dr. W. H. Stewart, New York City.

The Value of Lateral and Oblique Studies of the Chest: Dr. William A. Evans, Detroit, Mich.

Discussion, opened by Dr. Charles Lyman Green, St. Paul, Minn., and Dr. Percy Brown, Boston, Mass.

Thursday Morning at 8:30

Roentgen Ray Study of Dust Inhalation in the Granite Industry: Dr. D. C. Jarvis, Barre, Vermont. (By invitation.)

Lung Syphilis and Symbiotic Syphilitic-Tuberculous Lung Infection: Dr. W. W. Watkins, Phoenix, Ariz.

The Diagnosis of Primary Tumor of the Lung: Dr. Arthur C. Christie, Washington, D. C.

A Review of Chest Examinations in More Than Ten Thousand Cases: Dr. Kennon Dunham, Cincinnati, Ohio.

The Clinical Importance of the Different Types of Pulmonary Tuberculosis as Observed by Roentgen Examination: Dr. R. G. Allison, Minneapolis, Minn. (By invitation.)

Discussion of Papers, opened by Dr. Charles Lyman Greene, St. Paul, Minn.

Thursday Afternoon at 2:30

Lantern Slide Exhibit: One half hour.

THE CALDWELL LECTURE: *Peristalsis in Health and Disease:* Dr. Walter C. Alvarez, San Francisco, Calif., Assistant Professor of Research Medicine, George Williams Hooper Foundation for Medical Research, University of California Medical School. (By invitation.)

The Intralaryngeal Application of Radium for Papilloma: Dr. Preston M. Hickey, Detroit, Mich.

The Treatment of Carcinoma of the Breast by Imbedding Radium, Supplemented by X-Ray: Dr. Russell H. Boggs, Pittsburgh, Pa.

The Rationale of Radium-Therapy in Cancer: Dr. Isaac Levin, New York City. (By invitation.)

The Collateral Treatment of Malignant Patients Undergoing Radiotherapy: Dr. E. H. Skinner, Kansas City, Mo.

Cases Illustrating the Value of Prophylactic X-Ray Treatments: Dr. Samuel Stern, New York City.

Present Problems and Future Prospects of Deep Roentgen Therapy: Dr. Albert Soiland, Los Angeles, Calif.

Thursday Evening at 8:30

MOVING PICTURES

Technique of Examination of the Accessory Naval Sinuses and Mastoids: Dr. Frederick M. Law, New York City.

The Cancer Problem: Dr. J. M. Martin, Dallas, Texas.

Friday Morning at 9

Symposium—Technical.

Physical Investigation Work in Progress on Tubes and Accessories: Dr. W. D. Coolidge, Schenectady, N. Y.

The Influence of Scattered X-Rays in Roentgenography: Mr. R. B. Wilsey, Eastman Kodak Co., Rochester, N. Y. (By invitation.)

Practical Application of Mr. Wilsey's Results in General Roentgenology: Mr. Millard B. Hodgson, Eastman Kodak Co., Rochester, N. Y. (By invitation.)

On a Method of Making Quickly Roentgenographic Records of Screen Observations by Means of a Rotary Film-Holder: Dr. Percy Brown, Boston, Mass.

A New Device for the Protection of X-Ray Patients and Operators From Electric Shock from Any Part of the High Tension Circuit (with demonstration of same): Mr. Montford Morrison, Victor Electric Corporation, Chicago, Ill. (By invitation.)

Friday Afternoon at 2

Lantern Slide Exhibit: One half hour.

SYMPOSIUM ON ARTIFICIAL PNEUMOPERITONEUM

The Use of CO_2 in Producing Pneumoperitoneum: Dr. Walter C. Alvarez, San Francisco, Calif. (By invitation.)

Pneumoperitoneum as an Aid in the Differential Diagnosis of Disease of the Left Half of the Abdomen: Dr. A. F. Tyler, Omaha, Nebraska.

Pneumoperitoneum of the Pelvis (Preliminary Report): Dr. J. G. Van Zwaluwenburg and Dr. R. Peterson, Ann Arbor, Mich.

Diminutive Pneumoperitoneum (Intrauterine Oxygen Inflation Method) with Special Reference to Sterility and Allied Gynecological Conditions: Dr. I. C. Rubin, New York City. (By invitation.)

Discussion on the Symposium on Artificial Pneumoperitoneum, opened by Drs. Arthur Stein, New York, W. H. Stewart, New York, and L. R. Sante, St. Louis. (By invitation.)

An Unusual Case of Third Degree Burn (X-Ray) With Rapid Healing: Dr. Edward S. Blaine, Chicago, Ill.

Friday Evening

ADDRESSES MADE AT THE BANQUET

Toastmaster: Dr. A. W. Crane, Kalamazoo, Mich.

Special Address: *The Relation of Roent-*

genology to Clinical Medicine with Special Reference to Gastroenterology: Dr. R. Walter Mills, St. Louis, Mo. (By invitation.)

Remarks on European Trip: Dr. W. D. Coolidge, Schenectady, N. Y.

Remarks on European Trip: Dr. Walter C. Hill, Cleveland, Ohio.

A Historical Sketch of Roentgenology in Germany, 1914-1920: Dr. Leopold Jaches, New York City.

Forty-seven new names were added to the roll of active, corresponding and honorary members of the Society, as follows:

MEMBERSHIP

Allison, Robert G., M.D., Minneapolis, Minn.
Bader, Ellis R., M. D., Cincinnati, Ohio.
Ballard, Carl H., M.D., Omaha, Neb.
Bernstein, Benjamin M., M.D., Brooklyn, N. Y.
Berry, John M., M.D., Albany, N. Y.
Boardman, Walter W., M.D., San Francisco, Calif.
Cowherd, F. Garnett, M.D., Cumberland, Md.
Doyle, Alfred S., M.D., Philadelphia, Pa.
Groeschel, Lesser B., M.D., New York City.
Healy, T. R., M.D., Boston, Mass.
Kantor, John L., M.D., New York City.
Kern, M. F., M.D., St. Cloud, Minn.
Koenig, Edward C., Buffalo, N. Y.
Lafferty, Robert H., M.D., Charlotte, N. C.
Lamb, R. F., M.D., Portland, Maine.
Lambert, John H., M.D., Lowell, Mass.
Lindsey, John H., M.D., Fall River, Mass.
MacMillan, Alex, M.D., Tufts College, Mass.
Martin, Chas. L., M.D., Dallas, Texas.
Menville, Leon J., M.D., New Orleans.
Merrill, Adelbert C., M.D., Boston.
Morrison, L. B., M.D., Boston, Mass.
Nicholas, Bernard H., M.D., Cleveland.
Osmond, John D., M.D., Cleveland, Ohio.
Panneton, J. Eugene, M.D., Montreal.
Payne, Roy A., M.D., Portland, Oregon.
Perkins, Charles W., M.D., New York City.
Pierce, Harold J., M.D., Terre Haute, Ind.
Pillsbury, Henry C., M.D., Washington.
Quick, Douglas, M.D., New York City.
Reynolds, Lawrence, M.D., Boston, Mass.
Richards, Charles M., M.D., San Jose, Calif.
Sante, L. R., M.D., Webster Groves, Mo.
Spangler, Davis, M.D., Sherman, Texas.
Stevens, J. Thompson, M.D., Montclair, N. J.
Swanberg, Harold, M.D., Quincy, Ill.
Tovell, H. M., M.D., Toronto, Canada.
Upson, W. C., M.D., Battle Creek, Mich.
Ward, Charles B., M.D., Spokane, Wash.
White, Franklin W., M.D., Boston.
Widman, Bernard P., M.D., Philadelphia.
Williams, John G., M.D., Brooklyn, N. Y.
Woodall, Charles W., M.D., Schenectady, N. Y.

HONORARY MEMBERSHIP

Forsell, Prof. Gosta, Stockholm, Sweden.

CORRESPONDING MEMBERSHIP

Heuser, Carlo, M.D., Buenos Aires.
Kaplan, Adolofo, M.D., Santiago, Chile.
Martinez, Gonzalez, M.D., Porto Rico.

The list of present officers of the Society will be found at the head of the Editorial Section of this issue of the Journal.

NOTICE TO SOUTHERN ROENTGENOLOGISTS

The first meeting of the Section in Roentgenology of the Southern Medical Association will be held November 15, 1920, the first day of the regular meeting of the Association, at Louisville, Kentucky. Headquarters, Hotel Henry Watterson.

NOTICE OF SECOND ANNUAL MEETING EASTERN SECTION

The Second Annual Meeting of the Eastern Section of the American Roentgen Ray

Society will be held in Atlantic City at Haddon Hall-Chalfonte, on Friday evening and Saturday, January 28, 29, 1921. Make your hotel reservations early.

Communications regarding the program should be addressed to Dr. David R. Bowen, 82 West LaCrosse Ave., Lansdowne, Pa.

In all other matters concerning this meeting address Dr. Joseph M. Steiner, 103 Park Ave., New York City.

CORRESPONDENCE

24th September, 1920.

Secretary The American Roentgen Ray Society.

Dear Sir:

At the Thirtieth Annual Meeting, just held in Atlantic City, of the American Electrotherapeutic Society, the following officers were elected to serve for the ensuing year:

President

Byron Sprague Price, M.D.

Vice-Presidents

V. C. Kinney, M.D.
C. M. Sampson, M.D.
Charles Collins, M.D.
D. A. Cater, M.D.
W. T. Johnson, M.D.

Trustees

F. B. Granger, M.D.
F. H. Morse, M.D.
W. M. Clark, M.D.
E. C. Titus, M.D.
William Martin, M.D.
Frederic deKraft, M.D.

Secretary and Registrar

A. Bern Hirsh, M.D.

Treasurer

J. W. Travell, M.D.

If acceptable you may wish to insert the above into the news column of your Society's "Journal."

Yours very truly,

A. B. Hirsh

Secretary and Registrar.

NOTICES

Notice has just been received of the death of Dr. Herschel Harris of Sydney, Australia. An obituary by Dr. L. J. Clendinnen will appear in a forthcoming issue of the Journal.

TRANSLATIONS & ABSTRACTS

H. F. Wilkins, B.S., M.D., and Wm. C. Gewin, M.D. The Use of Radium in the Treatment of Metrorrhagia and Menorrhagia. (Paper read by title before the Chattahoochee Valley Medical & Surgical Association, at Columbus, Georgia, July 9, 1919, and subsequently published in *Radium.*)

1. In the discussion of these two conditions, it may not be out of place to mention some of the physiological effects of radium on cell life. All physiological or pathological effects of radio-active substance must be carried back to their action on protoplasm, whether it be the cells of plants or in the destruction of a neoplasm in the body, that is involved. A short exposure to radium accelerates the vital forces to a more energetic action of repair, while a more intense exposure inhibits them, which retardation may be cumulative and persistent through many generations of cell proliferation, hence the long time required to cure a radium burn.

2. There are various theories as to the specific effects of radio-active substances on cell life, and whether the radiation effects the enzymes of the cell is questionable. Suffice to say, that when we thoroughly understand the effects of radiation on biological cells, then we will be able to apply accurately radio-active therapeutics in the treatment of disease.

3. The treatment of uterine hemorrhage, with or without fibromyoma is so well established, that one must assume that a given dose will produce amennorrhoea. In women over thirty-five and under thirty, a temporary menopause can be brought about by a careful dosage, while in women over thirty the results will be less certain, and the number of cases of fibromyoma will shrink to insignificant proportions under proper dosage with radium.

4. Take for granted, then, that the above results are assurable, several problems are to be solved. The first of these, the proper selection of the cases for radiotherapy, and dosage concerns the general methods of applications and dosage of the radiation to obtain the results above mentioned. The conditions which are more often referred for this form of treatment are, first, those of excessive prolonged hemorrhage from the uterus with no gross pathological lesion, which occur at puberty, at the menopause, and to a less extent during the child-bearing period, and secondly, fibromyoma of the uterus in all its phases of development. The cause of the bleeding in the grossly normal uterus up to ten years ago was thought to lie in the anatomical lesions, which indicate various stages of inflammation either in the endometrium or in the muscles. Chronic endomotritis was applied to all conditions of the endometrium, in most cases of uterine hemorrhage. This idea as to the cause of uterine bleeding has been discredited by the more recent investigators where records have already been shown that the swollen congested edematous membrane is the counterpart or exaggeration of the intermenstral endometrium, and that it is concerned, no doubt, in the actual bleeding from the uterus, which, nevertheless, shows evidence of being stimulated by the same influence such as substances, which bring on menstruation. The latest researches show that such substances do exist in the corpus luteum, and in the placenta, and that in individuals suffering from uterine hemorrhage there is found a ripe corpus luteum, and in normal menstruation the cycle of hypoplasia and depletion through which the endometrium passes, is coincident with the cycle of development, and recession of the corpus luteum, and that the bleeding is dependent upon the corpus luteum is now absolutely believed. It is almost certain that the pathological, as well as the normal uterine bleeding, is due to some disturbance of the Graafian follicle in some stage of its development, whether this is effected by other granular substances, etc., or not. The pathological hemorrhage is a variation in amount, duration, character and periodicity from the normal menstrual flow.

5. If the abnormal uterine bleeding is nothing but a variation of the normal, and we wish to produce its cessation, the logical procedure is to destroy the essential element in the menstrual cycle, i.e., Graafian follicle. Next to the lymphocyte and the spermatozoa, the ripe Graafian follicle is most susceptible to the action of radium. It needs but a step to apply these agents to the Graafian follicle to bring about the condition of the normal or pathological uterine flow. The ripe follicle is much more

susceptible than is the primordial follicle, and if the dose of radium be regulated to destroy only the follicles of an advanced degree of development, then a definite period of amenorrhea can be brought about, depending on the number of primordial or immature follicles remaining after the exposure to radium.

6. Uterine hemorrhage is often accompanied by gross anatomical lesions in the uterus, and a complete analysis concerning such cases shows that in four conditions does there appear to be any association between the bleeding and the pathological conditions and changes. The conditions which cause hemorrhage from the uterus are (a) a small percentage of cases of hemorrhage due to pelvic inflammation, (b) a large percentage due to retro-version, although the displacement may be complicated with cystic ovary, infantile uterus, etc., (c) the third group includes the ulcer-active conditions, such as carcinoma, polypus, pedunculated submucous fibroids, (d) the fourth cause of uterine hemorrhage is fibromyoma of the uterus. There is no doubt as to the definite coincidence of these conditions, however, the casual relationship is still obscure, that menorrhagia may be coincident with fibroid without any casual relationship and that the bleeding may recur after the fibroid has disappeared, without a recurrence of the fibroid can be easily substantiated by many cases.

7. An interesting question which arises from a study of these cases is what relation they may have to the uterine hemorrhage when the bleeding reappears in the absence of the tumor, but one can not refrain from feeling that there is a coincidence in the presence of a fibroid and a functional menorrhagia. A close study of these cases will show that there are some casual relationships between many fibroids and the uterine bleeding, and one is almost forced to conclude that all fibroids exercise a contributary, if not an essential role in many cases of bleeding from the uterus, because in no case of fibromyoma treated by radiotherapy, that has been reported, has there been any more trouble experienced than has been encountered in the treatment of the grossly normal uterus. The excessive hemorrhage in this class of cases is due to a disturbance in the proper relationship between the elemnts which control menstruation, and hence the ideal treatment is to restore that relationship. In the hemorrhage in young women, the disturbance is one of development, and every effort should be made to restore this balance by general treatment, which is to replace deficient factors by curettage, if necessary, even though improvements follow only in about 10 per cent of the cases so treated. It has been found that the treatment by radium is far better in all these cases. In women over thirty partial amenorrhea can be promised with somewhat greater difficulty, but in most instances, certainly. In this class the promise of a permanent menopause, rather than to any radiotherapeusis that may have been used.

8. Six hundred and twenty-five milligram hours intra-uterine, with 0.5 millimeter filter is safe in a woman under thirty-five. Over that the dosage is better cut down by a millimeter of brass. In women around thirty-eight or over, radiotherapy becomes the method of choice, because the menstrual balance is disturbed by the approach of old age and the cessation of the child bearing period, probably due to the decadence of the ovarion function. Since the natural menopause is imminent, it would seem to be logical to precipitate it and try to save the woman months or even years of partial or complete incapacity from uterine hemorrhage. In such cases massive dosages are indicated from the starting of the radiotherapeusis.

9. The treatment of bleeding associated with retroversion is very much like the above. The most prominent symptom, the displacement, should be corrected in all cases, if possible, without operation, and the effect upon the bleeding noted. In younger women an operation should be performed if reduction of the displaced uterus fails. In older women having the symptoms from the retroversion, it seems fairer to leave the displacement alone, because the reduction in older women has not, in our experience, relieved the bleeding. In these women radiotheraphy should be resorted to at the beginning of the hemorrhage.

10. The excessive hemorrhage associated with fibromyoma of the uterus can not be treated alone, but must be considered along with the whole question of the proper treatment of fibromyoma. Before the use of radium there were certain principles governing the treatment of fibrosis. The first of these was that the fibroid itself was a menace and caused no damage except by its size, and that would not change from a benign tumor to a sarcoma.

Secondly, that such a zbroid should not be treated unless it gave symptoms, because sarcoma is so rare that operating on mere superstition would harm more individuals than it would help. The symptoms for which operation was advised were, in the first place excessive hemorrhage, secondly, variations due to pressure on nerves or organs, and thirdly, rapid growth or large size of benign tumor mass.

11. With radium as a curative agent the problem as to the best method of treatment remains the same, i.e., the new problem of the proper class of cases needing treatment of the fibromyoma which are suitable for radio-active treatment, and of those cases which should be operated on. As above stated, the results to be expected from radiation are, first, the cessation of bleeding; second, the shrinking of the fibromyoma. This shrinkage requires varying lengths of time in different cases, and should receive scant consideration from the radiotherapeutist. If a mass is pressing on any important organ, or if the tumor is extremely large, and if the patient's health permits operative risk, the mechanical removal of the tumor seems to be better treatment under our present status of information, however, any excessive hemorrhage in these cases should receive treatment by radium in all cases in which a menopause is acceptable, but in younger women this method of treatment is not indicated unless the general condition of the patient would not permit of surgical interference. Because in the younger class if radium is used it should be applied in massive doses, in which we expect only a complete cessation of the ability to bear children. A menopause is almost sure to result if any good is obtained from this treatment. Then if we temporize with small doses of radiotherapy, the chances are that a sarcomatous condition would result, and more energetic application of the radium would have to be used if results are to be expected.

W. W. Belden.

De Niord, Hollis H., M.D., and Richard N., M.D., and Schreiner, Bernard F., M.D., Buffalo. The Effect of Roentgen Rays on the Metabolism of Cancer Patients. (*Arch. of Int. Med.*, Vol. 25, No. 1, January 15, 1920.)

The ever increasing scope of blood chemistry studies has enabled the authors to estimate quantitatively factors representing protein, fat, carbohydrate and salt metabolism and storage. Everyone is familiar with the cachexia of cancer sufferers, and the early stage at which it sometimes appears, making it practically a diagnostic symptom of malignancy. With this in mind, their efforts have been directed toward the actual cause of the loss of weight, whether due to (1) deficient food intake; (2) absorption of toxins from secondary infection of the tumor, or (3) to some specific action of cancer cells that prevents storage and utilization of foodstuffs. Following radium and roentgen-ray treatments, many patients show marked improvement or are cured, and the question arises whether the roentgen ray produces any discernible change in the blood chemistry and how long such a change must exist to effect a general improved metabolism, and whether the effect of the roentgen ray is a general one or only a local destructive action on tumor cells. They, therefore, chose ten readily estimable factors for the study of the blood chemistry, and the complete studies were made immediately before roentgen ray exposure, one half an hour after, and on the next day, approximately twenty-four hours afterward. The entire study is preliminary to, and in the nature of a report of, the broader observations with which they are now engaged. The following were estimated in mg. per 100 c.c. of blood in each instance: 1. Urea. 2. Creatinin. 3. Uric acid. 4. Chlorids. 5. Cholesterol. 6. Fatty acids. 7. Total fats. 8. Sugar. 9. Diastatic activity. 10. Plasma and corpuscle percentage. The cases selected for study were not taken at random as only those patients were selected who were practically free from renal disease, in order to obviate the matter of retentions. Several control studies were made on normal people subjected to the same roentgen ray exposure. With another control group of cancer patients, they took 60 c.c. of blood at the same interval as in the roentgen ray studies but without roentgen ray exposure.

Their object in this paper has been to note the effect of roentgen rays on cancer patients, as manifested by changes in their blood chemistry, and to continue investigation of the individual blood factors where it seemed to be indicated. 1. Urea, urea nitrogen and creatinin showing nothing characteristic of the cancer

patient. 2. The moderate uric acidemia which exists for a short period of time after exposure to roentgen rays is the result of nuclear degeneration but is not especially characteristic of malignancy. 3. The sodium chlorid content of cancer patients is altered neither by the presence of the tumor nor the exposure to roentgen rays. 4. The cholesterol, fatty acids and total fats are generally increased in the blood, but this is not in proportion to the duration of exposure to the roentgen ray or varied as to the type of tumor. The increase of cholesterol in the blood is probably due to cellular autolysis with liberation of cholesterol, induced by the action of the roentgen rays. Fatty acids and total fats are consistently high in the blood of cancer patients and this increase is reduced by the roentgen rays. They do not care to give any reason or hypothesis for the reduction, as they are at present carrying on further studies along this line.

5. There is nothing in the behavior of the blood sugar or diastatic activity that is diagnostic of cancer. They have noted, however, that the roentgen rays activate the diastase for a short period of time to a greater than normal activity. 6. The plasma and corpuscle percentages were unaltered by the effect of the rays, and were of no diagnostic value in cancer.

W. W. Belden.

Wise, Fred, M.D. Roentgen-Ray Treatment of Widespread and Generalized Diseases of the Skin. (*J. Am. M. Assn.*, Vol. 73, No. 20, p. 1491.)

In the early days of the roentgen ray, it was used empirically in the following:

"For example, such affections as epithelioma and sarcoma, the various granulomas, keloid, ringworm of the hairy surfaces, and other diseases which did not readily respond to the older methods of treatment in common use at the time, would be, so to speak, consigned to the mercies of the roentgen ray, to reap the benefits of, or to suffer the evils from a subtle and powerful therapeutic agent, the precise nature and action of which is to this day unknown. Even in such relatively small and well defined lesions as basal cell epitheliomas, keloids, warts and circumscribed granulomas, the administration of the roentgen ray was at one time, not far gone, a more or less haphazard, indeterminate process, the outcome of which, if it resulted favorably, was often at best only 'the happy combination of fortuitous circumstances.' "

EXACTNESS IN THE ADMINISTRATION OF DOSAGE OF RAYS

"As is well known, the last few years have witnessed great strides in the science and art of roentgenotherapy as applied to cutaneous affections. Improvements in the manufacture of the various types of exciting apparatus, and in devices for measuring the quality and quantity of the rays, have done much toward the introduction of many refinements in technic, so that we are enabled today to measure the exact quality and to determine the exact quantity of a given roentgen-ray emanation, without the least difficulty; in other words, we can easily administer an exact dosage of roentgen rays. These improvements in apparatus and advances in technic have culminated in the production of the Coolidge tube with its remarkable flexibility and its steady delivery of rays of uniform quality.

"The present-day degree of perfection attained in this method of treatment of skin diseases may therefore be measured by the facility and the simplicity with which a given dose may be safely and accurately administered, within a specified and reasonable length of time. This degree of perfection was not arrived at without much laborious experimentation and investigation; and the modern dermatologist owes a large debt of gratitude to such diligent workers and scientists as Sabouraud and Noire, Benoist, Holzknecht, Kienbock, Pusey and Caldwell, MacKee and Remer, Witherbee, Shearer, Corbett, Hampson and many others."

The technic which is now employed is that which is used in the Vanderbilt Clinic under the direction of Dr. John Remer. This technic was elaborated and standardized by Drs. McKee and Remer. It does not depend upon the various titles radiometer or similar devices but the dose is regulated by the spark-gap backup and the quantity of current going through the tube and the length of time of exposure.

"To obtain one Holzknecht unit at 'skin distance,' that is, with the exposed pastil of barium platinocyanid resting on the skin, the

following factors were found to be serviceable as convenient working constants: length of parallel spark gap, 6 inches; amount of current passing through the tube, 2 milliamperes; distance from the anode to the skin, 8 inches; time of exposure, three minutes.

"With the Coolidge tube backing up a 6-inch parallel spark gap, the Benoist penetrometer reading is approximately No. 8, that is, a 'hard' ray. Experience has taught that a No. 8 to 9 B ray is to be preferred in dermatologic practice, to much softer or much harder amanations."

W. W. Belden.

Langmead: Notes of a Case of Esophagectasis in an Infant, with Radiograms. (*Proc. Roy. Soc. Med.* Vol. XIII, No. 5, March, 1920.)

Patient was a baby girl, aged fifteen months, who vomited after nearly every feeding. Family history unimportant; child born at term, normal labor. History of vomiting, not projectile, about one hour after feeding. Vomitus was unaltered milk. Physical examination revealed an emaciated child with lively knee jerks. Urine contained acetone.

Fluoroscopy after a bismuth meal revealed a dilatation of the lower esophagus, about the size of a hen's egg. A small amount of food entered the stomach. The esophageal condition was the only defect observed, and was believed to be due to congenital want of relaxations of the cardiac sphincter. No operation was deemed advisable. Attempts to pass a tube without anesthesia were uniformly unsuccessful. The child left the hospital unrelieved. It would be of interest to know the final outcome of this case.

L. S. Goin.

Pickerel. Extensive Lesions of Anthracosis and Pneumoconiosis with Absolute Absence of Physical Signs. (*J. de radiol. et d'électrol.* 1920, Vol. 4, p. 34.)

To distinguish pneumoconiosis from certain forms of pulmonary tuberculosis is often difficult in radiology. In the case cited the radiological features offered such a contrast with the stethoscopic signs which were entirely lacking. M. M., a joiner, having suffered for two years with enteritis and abdominal pains, came to examination for a suspected hepatic lesion. To the surprise of all concerned, when the thorax was thrown upon the screen unexpected lesions were found. The edges of the lungs were full of dark spots and opaque granulations extended over both lungs, the more luminous standing out in relief on the emphysematous parenchyma. An opaque bilateral chain of cervical ganglions showed. The apices showed clearly upon respiration, the right a little darker. Diminution of the extent of the movement of the right diaphragm. This multitude of punctiform shadows, so opaque and so regularly distributed without predominence at apices seemed more like anthracosis, but the man's profession made that seem unlikely. Questioning showed that in his work however as a joiner he had been repairing coal wagons for over six years and had breathed much of the coal dust. His symptoms and treatment heretofore had been directed toward a possible intestinal disorder. He had lost 10 kilos in two years and sometimes expectorated. Sputum negative. Previous lack of respiratory trouble and negative auscultation made the explanation of the lung appearance as healed tuberculosis seem improbable. The case is cited merely to report an observation of pulmonary trouble whose discovery was due entirely to the radiological examination.

Skinner.

THE AMERICAN JOURNAL OF ROENTGENOLOGY

Editor, H. M. Imboden, M.D., New York

VOL. VII (NEW SERIES) NOVEMBER, 1920 No. 11

THE RELATION OF ROENTGENOLOGY TO CLINICAL MEDICINE WITH SPECIAL REFERENCE TO GASTRO-ENTEROLOGY*

By R. WALTER MILLS, M.D.

ST. LOUIS, MISSOURI

IT is my appreciated privilege to address you, and in accepting the invitation I welcome the occasion to discuss through your suggestion a subject that must have been with you, as with me, a matter of reflection. The subject was welcome too, because had it not been suggested I should hardly have had the temerity to air certain more or less intangible views heretofore painfully suppressed; for primarily I am not of your cloth, and have felt that possible heresies might not find favor among the roentgenologically elect. My regrets and plea for indulgence should this prove the case! It may happily be, however, that our views as professed roentgenologist or clinician become convergent in the end to mutual ground through respect for truth, service, the advancement of our beloved profession—and ourselves. But lest it be feared that I have violent Bolshevistic medical propaganda to scatter, let the worst be confessed at once, that my address pertains to a consideration of certain relationships and methods of utilizing roentgenology in clinical medicine, of the difficulty of advancing along present lines, and the possibility of more effective use of the *x*-ray through limitation in certain branches of roentgenology in a closer relationship to clinical medicine. As it is impossible to consider such a proposition in all branches, gastro-intestinal work may serve as an illustration, since it is peculiarly a problem demanding consideration along the lines indicated, though it does seem that other divisions of roentgenology are open to much the same sort of interrogation. Once again let me ask your charity. I shall be quite frank. Either we must discuss the subject or let it carefully alone. If any position taken seems at all radical let me plead the sincerity of my views and interest.

There is no precedent in any specialty for such a revolutionary factor suddenly developing as the *x*-ray has proven to be in gastro-enterology. Successful abdominal diagnosis prior to its advent was devious and largely a matter of shrewd guesswork. It has been transformed by roentgenology as practiced by skilled men into one of the most accurate subjects in clinical medicine. The influence of the *x*-ray on subjects collateral to gastro-enterology, surgery, topographical anatomy and alimentary physiology, is very great—only relatively less important. It has no limitations. The limitations are our own.

*Read by invitation at the Twenty-first Annual Meeting of THE AMERICAN ROENTGEN RAY SOCIETY, Minneapolis, Minn., September 14-17, 1920

Its only weakness is in its strength, in that it displays a living pathology so bewildering that we are as yet unable to arrange much of the evidence to fit present conceptions. It is conventional to assume a pose of conservatism on the value of the x-ray in gastro-intestinal work, but I have little doubt that the foregoing is about what with good reason we really believe, and it certainly seems the position of thinking clinicians to-day.

No one can hazard what the future of roentgenology will be, nor is it possible to imagine its accomplishments in the centuries to come; but there is every indication that it will continue to be highly revolutionary and very wonderful. We must recall that roentgenology is in no way limited to clinical medicine. There are even now indications of its future extensive utility in anatomy—topographical, osseous and organological, and in embryology. It will revolutionize certain conceptions of physiology, especially of alimentary motility and the relations to such of secretory function. It will be of help in pharmacology in observing reactions to drugs. It will have a great field in pathology in the location and determination of the extent of disease and in the study of abnormal densities as a reflection of the morbid processes in organs. There are many other opportunities for roentgenology having only collateral interest with clinical medicine, as in the fields of anthropology, biology generally, botany, geology, metallurgy and other purely scientific branches, not to mention its use in the arts and commerce. It is fitting that we take stock of the present in an effort to further the future.

It is a curious fact that what was accepted as knowledge yesterday often prevents the acquisition of subsequent truth. We resent any change in our laboriously accumulated information and ideas that may leave us without a comfortable base. We cling, concede and modify, and while it is no doubt well in some ways that this is so, since each new idea and contention must survive by beating down this inertia through sheer weight of truth, it is unfortunate that many fundamental facts are deflected or delayed in recognition by preconceived notions. A similar condition obtains with regard to our medical economics. We build our methods of practice by reconstructing previous methods of practice and ways of procedure, unmindful that times and conditions are changed and that more direct though radical ways may better serve.

Medical specialties are practically but a thing of the last generation. Ophthalmology was obvious, laryngology hardly less so; dermatology, neurology and the others followed fast; surgery, more slowly accouchée, labors still to some extent under the tender care of the practitioner who, from the advances of the chest and cardiovascular men above, the gastro-enterologist within, and the proctologist below, feels himself being rapidly restricted to diseases of the umbilicus. In such an age of specialization and dismemberment of medical practice suddenly appeared an unprecedented and powerful means of physical examination—unprecedented in its ways of operation touching every other specialty and allied medical science not casually but intimately, fundamentally, and often uncomfortably. Not abstractly as did laboratory work when generally introduced, but prying into clinical intimacies and faiths with ruthlessness. It was obvious from the first that roentgenology must become a specialty. We already had specialties in everything else. This was a simple enough business in the pioneer days when it was a question of finding someone to run the machine, and then but a matter of bones and bullets. I run ahead of my story by saying that the general practice of roentgenology has become in its intellectual requirements the most demanding and in its practice the most difficult of all specialties; the only one that to its full development requires a considerable knowledge of some of the most difficult phases of practically all other specialties and in addition embodies a technique which constitutes an art in itself.

The future of general roentgenology has even been held dubious on this account. Most

of us recall Dr. Hulse's address before this body several years ago, in which he suggested that the shadow of the dissolution of general roentgenology and its apportionment among the various specialties was upon us. However there is no present indication of such an untimely occurrence. Roentgenology waxes constantly more powerful and far-reaching, though one must admit that this seems at least due as much to its inherent strength as to our ability to harness it.

There are three ways of employing the x-ray in the practice of clinical medicine. Roentgenology may be practiced as a general consulting specialty as at present. It may be utilized by the clinician himself in his own branch. Roentgenology may be divided into subspecialties, each having as its field one or a limited and associated few of the major clinical specialties. I should like to speak of the second possibility first, the clinician as his own roentgenologist, theoretically the ideal arrangement, though as a matter of fact still awaiting a conclusive demonstration of its general possibility.

The technique of roentgenology is difficult and requires years to full accomplishment. Some time ago we heard much of reducing plate technique to formulae by which any novice could consistently reproduce the best results of the old masters. Such an idea omits several imponderables—to illustrate, the penetrability of the individual patient, the considerable matter of pose embodying a nice judgment of regional anatomy and statics, and the psychological control of the patient. One need hardly mention the time consumed in developing roentgenoscopic skill and the difficulty of maintaining a multiple factored technique in highest efficiency. The clinician has not the time to devote to the technical end, nor has he the knowledge to oversee and control a purely technical worker. He is fully occupied with affairs of his own, in keeping informed in his own line, and by the thousand time-consuming details, interviews, consultations and questions of management unavoidably associated with the treatment of patients. Above all he has not training nor time to acquire training in the interpretation of plate or roentgenoscopic shadows; he lacks the ability of the one constantly devoting himself to the art and deriving help from other problems. Again, few internists have a practice large enough to afford a material sufficient to acquire an affective knowledge of the roentgenological side. To become proficient one must see a large number of cases; must soak in his subject, become sensitized to it, constantly accumulating additions to his repertoire. There is a story told of Osler's quizzing a student as to how he came to recognize a certain patient as having paralysis agitans. The student guessed he knew it by the gait, by the tremor and the pill-rolling motion. "No," answered the professor; "Seen it before." Proficiency is not to be expected in any art without practice. The clinician may acquire a fair knowledge of the roentgenology of his subject, he may even find it so valuable and illuminative as to cause him to feel that the time devoted to it has been well spent; but for him to exhaust the possibilities, to squeeze from the method the last per cent of efficiency without limiting his purely clinical activities, seems hardly possible.

At that the clinician has something in his favor. His clinical knowledge will save him so that if he get but moderate assistance from his x-ray he can use it as a valuable check; at least he will be saved those frightful debauches of error met with in the ministrations of the inexperienced x-ray worker. Candor forces me to say that if he be a skilled gastro-enterologist and have but indifferent x-ray help available he may be better off doing his own work, as he can then be at liberty to accentuate his clinical findings; which he cannot so well do on the other hand if he have a formal opinion from an x-ray adviser which he takes considerable responsibility in overruling.

The clinician may acquire a knowledge of roentgenology, though at an impracticable loss of time. He may devote sufficient time to hospital work to gain proficiency, or he

may associate himself with others doing gastro-intestinal work, devoting himself to the *x*-ray end. In all these instances he becomes in large measure a roentgenologist whether he aspire to the honor or not. Certainly by so doing he limits his clinical capacity, though the arrangement may be highly effective and satisfactory; for the roentgenologist may develop from the clinical side.

One thing is sure; if the clinician attempts *x*-ray work at all he should develop it to a respectable degree. Doing some half-hearted fluoroscopic stunt under the guise of an *x*-ray examination is unfair if not dishonest to the patient, and a raw injustice to the men who have developed the subject often at bitter cost to themselves. Another phase of the situation is seen in internists accompanying their patients to the roentgenologist's, insisting on possessing the plates and so on. It is doubtful whether the clinician derives anything other than a mildly instructive value from such practice, and there is some question as to whether he is not wasting his time, for it hardly seems possible that he can learn enough in this fashion to make it worth while. It is doubtful too whether the roentgenologist is altogether happy in the arrangement. A different relationship between clinical and roentgenological sides is seen in the use of the *x*-ray by master specialists in their own lines when the roentgenological problems are sharply limited. Genito-urinary work, neurological surgery, and the problems of the rhinologist are instances in point. Certain men in these fields develop a highly specialized roentgenological service which they use with great effectiveness, this because they naturally cannot command help commensurate with their own knowledge in the general specialty. Even here they labor under the difficulty of lack of fundamental knowledge of roentgenology. However, some truly great advances have been made in this way, as frequently occurs where intensified combinations of various specialties are brought in contact.

All these efforts at adjustment reflect the fact that there is certainly an increasing tendency for clinicians to assign a position of greater importance to roentgenology, perhaps a secondary reaction after the first violent efforts at reconciliation and adaptation on the basis of the sometimes over-enthusiastic claims of the roentgenologists and prejudiced antagonism of clinicians. There is also indicated a desire on the part of clinicians generally to bring *x*-ray work in all lines into more immediate association. Though to repeat, one cannot but feel for reasons mentioned that such arrangements are destined to give the highest degree of satisfaction. The clinician is in a way rehearsing the development of the art; he has not yet encountered the obstacles. At the last meeting of the American Gastro-Enterological Association, forty per cent of papers were on, or discussed inclusively *x*-ray subjects. These papers were by orthodox roentgenologists, by clinicians and roentgenologists conjointly, by clinicians doing their own *x*-ray work, by clinicians whose *x*-ray work was done by others under their supervision, and by certain men doing intensive *x*-ray work or work utilizing the *x*-ray. The banquet address was by Dr. George on a purely *x*-ray subject. To repeat, it is impossible to explain this drift otherwise than that it represents effort at adjustment.

The second possibility as to the employment of roentgenology is as a general consulting specialty, the chief present arrangement. Its chief disadvantage has been foreshadowed in mention of the extent of the requirements of such a specialty. May it be but mentioned that it implies knowledge of all technical advances and refinements of technique, a knowledge of plastic roentgenography of the abdomen, of gall-bladder work and pneumo-roentgenology, of pylography, of cardiac mensuration, and of roentgen therapy now augmented by a new world in radium therapy. General roentgenology implies an extensive knowledge of gross pathology, a knowledge of alimentary physiology pertaining to motility, of the thousand exceptions and chameleon-like visceral changes resulting from bodily type, malstatic condi-

tions, variability in muscular development and tonus, and sensibility to pressure stimulation. It requires a familiarity with pathological statistics, operative surgery, of an unwritten topographical anatomy, orthopedics and surgical neurological diagnosis. It implies a knowledge of cranial osteology and of the variations encountered, especially of the sinuses—a life work in itself. A score of other equally difficult and various requirements come to mind. Recall, too, that in all these subjects the roentgenologist must often meet highly intensified clinicians with years of experience and accumulated judgment. Yet there are master roentgenologists whom we may indeed honor for the fullness of their accomplishments. Let it be recalled, however, that they have had the advantage of evolution with the specialty. Only the pioneer builds most soundly and fully. Can the succeeding generations successfully follow in their steps, confronted with the subject in its present form discouragingly vast and arithmetically progressive in its scope and requirements. It is difficult to believe.

There always will be a great field for the general specialty. Perhaps the majority of those following roentgenology in the future as in the past will be general men. There must be heads of hospital and group departments. In many places there is insufficient material and demand for subspecialization; the situation parallels the relationship of the general internist to the gastro-enterologist or the specialist in heart or pulmonary affections. But as in these fields it may be questioned whether best progress or superlative results are obtainable along general lines. There is a reflection of this in the fact that the leaders of your profession have made its progress by accentuating certain lines of work with which their names are associated. On the other hand, there can be nothing but advantage in a broad general knowledge of the subject by those who may ultimately restrict themselves.

A disadvantage of general roentgenology as usually practiced is that the roentgenological consultant is without or is largely deprived of clinical information—he is supposed to give his opinion on *x*-ray evidence alone with the idea that it will then be uncolored by any clinical facts. He may have no or but little directional access to history or physical findings. Should he for instance momentarily palpate a previously undetected abdominal tumor not giving *x*-ray evidence he might be hard put to it for a way to contribute his fact. Frequently most valuable information may be elicited during the course of a roentgenological examination. The most favorable opportunities for questioning and physically examining the patient arise at such time. They are taboo for the strict roentgenological consultant. He is supposed to do a complete or partial examination at the direction of the clinician. There seems a fearful lot of lost motion and lack of economy in such an arrangement. Theoretically every case must be plated to the last degree for all possible conditions, whether there be indication of their presence or not. What of the play of probabilities in such an arrangement? There are no positive facts in medicine—only varying probabilities. Much *x*-ray evidence amounts to probability or possibility only; yet it has its definite value none the less. The one time discussion of the advisability of mentioning suspicious gallstone shadows, always a moot question whose validity is expressed by its constant recurrence, is an illustration in point. All gallstone and gall-bladder shadows form a gradient between highly positive evidence and evidence that is indecisive. Has the latter no value? It may help to indicate the source of a serious focal infection and be of greatest worth taken in conjunction with clinical evidence of like inference. The same for cancer of the stomach, duodenal ulcer, and many other conditions. Are we justified in ignoring this fact in order to conform to our ritual? The idea is of course to restrict the roentgenologist that he may in no way be influenced or contaminated by clinical considerations, and incidentally that the clinician may have a comfortable yes-and-no basis on which to stand. It is difficult

to be satisfied with such an arrangement. Unless roentgenology is to be limited by rules like fly-fishing or fox-hunting, to be done in a certain way to the prejudice of results, we must have broader outlets. As a matter of fact many roentgenologists subscribe to this protest by obtaining, as they should have a right to, such directional evidence as can be collected in one way or another. The whole situation does not make for results or amity.

There are other less easily referred to sources of irritation. In a way the gastro-enterologist feels that any method of examination in his field should be under his own jurisdiction. We must admit that it is not soothing that he must refer his patients to another for the most informative and important examination, and that the patient usually has a pretty good idea of the situation. The clinician cannot, from lack of experience, appreciate the difficulties of the roentgenologist's interpretations, but judges that his specialty is founded on a species of technical knowledge not open to himself. The clinician too has suffered at the hands of incompetents who lack knowledge and do not always seem to feel obliged to conform to the ethics of the profession. For all styled roentgenologists are not as we are; there are many publicans and sinners in the form of ill-trained men, commercial x-ray photographers, interns, sisters, and especially the technician of the small hospital taking great pride in its x-ray department founded by a wealthy benefactor. From these the clinician does not always escape. The very vastness and nature of general roentgenology makes it possible for such offenders to trouble where it would not be possible were the field divided among roentgenological experts whose profession and reputation implied an exhaustive special knowledge of their subjects and unimpeachable ethical standing.

There remains a third possible manner of utilizing roentgenology in clinical medicine; through an intensified subspecialization most effectively in association with clinical findings. It is realized that this is not the conventional method that has been developed, perhaps without a definite objective and along the lines of least resistance, yet which many careful men believe to be the most favorable arrangement possible at present. It can only be an advantage however to consider the situation from all sides.

There is no question of the extent of the opportunity for the truly expert roentgenologist in any line. It does seem that attempting to occupy too great a field by either roentgenologist or clinician is not conducive to exhaustive knowledge and best results. Why may we not have limited consulting roentgenological fields within the general specialty in the same way that we have subspecialization in certain medical and many non-medical lines; consulting engineers of a dozen sorts, specialization in a thousand forms in the business world. Medicine has always been slow in profiting by examples outside of the profession. The ghost of the old practitioner is still over us.

Such limitation would have multifold advantages. There is no question but that its members would be much appreciated by the various clinical groups. There can be nothing narrowing in such limitation. Who could say that limitation in other lines is not highly satisfactory when the field is large enough, of which there can be no question in roentgenology. Men like Harvey Cushing and Chevalier Jackson, essentially subspecialists, are indeed of the broadest type. The arrangement would certainly be a source of satisfaction to its practitioners, who would not feel that their efforts were being dissipated over too large a field.

I may anticipate your possibly not approving query as to what is meant by closer relationship to clinical medicine, for it is realized that this is the crux of the proposition. Ideally it would imply first a knowledge of the clinical aspects of the subject, especially the diagnostic side obtained if possible by actual service; a knowledge of the pathology, pathological statistics and literature of the branch; full familiarity with the matter

of history-taking and interpretation, and skill in physical examination when such may be of help in roentgenological interpretation, as in abdominal palpation. It should embody a familiarity with the surgery of the subject. An almost unattached field of opportunity lies in the possibilities which roentgenology affords for aiding in the problems of abdominal operative surgery. Recall that such a roentgenologist would see more of the judicial problems of surgery than many surgeons, having access to a larger and selected material. I can not but feel that history and laboratory findings should be available before the roentgenological examination is begun. What other sort of medical consultation implies that one of the consultants be deprived of all available information and left to work out his fate on his own resources?

There is one question with regard to the method advocated which is most essential and on which its feasibility rests—the question as to whether the roentgenological opinion would not be colored with clinical evidence. This need in no way be the case, but the roentgenological consultant must be meticulously honest with himself and his consultant. It is impossible to believe that because the roentgenologist had knowledge of clinical findings suggesting a localized pulmonary tuberculosis, that this would lead him to read more into his plates than was justified. Rather it would stimulate him to redouble his efforts; or having a doubtful finding it would add to the clinician's presumption. The method proposed represents in essence an effort to realize on clinical knowledge for more effective interpretation of roentgenological evidence; to conserve and emphasize the factor of probabilities, and to obtain the benefit of directional clinical indications in conducting the x-ray examination; to convey to the consulting clinician collateral evidence incidentally encountered, and especially to convey the real diagnostic weight of the x-ray evidence which he cannot so closely appreciate otherwise. Such a relationship would furnish too a common meeting ground for consultation in place of a one-sided submission of certain findings on a certain kind of examination now largely in vogue. It is the universal practice of men to reach important decisions only after personal debate, and there are obvious reasons for this custom.

We recognize the value of correlating clinical and roentgenological findings by certain of our present practices. The roentgenologist identifies a certain abdominal tenderness as registering with the appendix or a gastric ulcer crater. He identifies a palpable mass as corresponding to a defective visceral outline, this with diagnostic helpfulness; yet he is making concessions in so doing, for clinical findings are being utilized. May I attempt to illustrate the value of the method suggested. The possible outline of a slightly enlarged gall-bladder may be suggested in plates. The roentgenologist for one fleeting moment palpated a mass corresponding in position, size and contour to the doubtful plate shadow. The clinician did not happen to make his examination at a time when this was possible. Two doubtful findings pointing to the same conclusion here result in a strong probability. What is the alternative for the roentgenologist? He may either mention the suspicious gall-bladder shadow and in principle be condemned for not furnishing a definite opinion, or he may consider it not safe and sane evidence, ignore it, and be condemned again for the ineffectiveness of his method. He may consider abdominal palpation not in his line, and the patient will foot the bill of disaster. Other instances may illustrate. The illustrations are actual occurrences; many similar situations are within the experience of any of you. In a man of broad powerful physique a retrocecal appendix is made visible only on certain manipulations of the overlying cecum. When so made apparent and manipulated in a certain way it is found to be questionably tender, but only on such manipulation. The appendix is not structurally suggestive. There is a history of an attack of pain in the right upper abdomen

somewhat suggestion gallstone colic. There is no roentgenological evidence of gall-bladder disease. The clinician suspects gall-bladder disease. He has obtained no local tenderness as was elicited by the roentgenologist through the help of the maneuver mentioned. The roentgenologist, if highly orthodox, will report simply a retrocecal appendix not necessarily significant of a pathology. If a trifle less orthodox he might state that a somewhat tender retrocecal appendix was present. The roentgenologist knows nothing of the previous attack of right upper quadrant pain. The clinician will hardly be drawn away from his gall-bladder idea by the report of a retrocecal appendix, even if slightly tender; the appendix is as a rule tender where there is a neighboring inflammation. The clinician knows nothing of the high cecum resulting in the appendix approximating the gall-bladder region—the roentgenologist has no occasion to mention it. If however our consulting roentgenoligist had full access to clinical findings the parts of the puzzle would at once click into place—a subacute appendicitis beginning with an attack of pain whose location approximated the gall-bladder region on account of the appendix being retrocecal and high, contributed to by the physical type of the patient. The clinician could not reach such an opinion from his own findings or on evidence of the usually approved type furnished by the roentgenologist. Another illustration: A patient gives a history of an attack indicating a previous right upper quadrant local peritonitis. Physical findings are negative. Plates show a constantly filled and constantly perfect cap with the possible exception of certain slight irregularities along its lower border not identical in different plates and absolutely as near a fifty-fifty proposition as between an organic condition and spasm is possible. What will be the roentgenologist's position if he knows nothing of the history which suggests on probabilities either a leaking duodenal ulcer or a pericholecystitis? Since his evidence is strictly indecisive the broad logical thing to do would be to ignore conservatively the slight suggestion of a pathology and report his findings negative. A duodenal ulcer giving such slight *x*-ray evidence is not usually so serious a matter. The clinician too would be led to believe that the condition did not result from ulcer, since he would rightly judge that an ulcer resulting in local peritonitis would probably give roentgenological evidence. His next probability would be gall-bladder disease with pericholecystitis, at once bringing up the question of operation. Certain gall-bladder pathologies are said to give histories simulating ulcer. But this possibility is a bad second. He has absolutely no clinical evidence of gall-bladder disease, and the roentgenologist's findings are entirely negative for such. The clinician is nowhere—he is worse off than if he had had no *x*-ray examination done, for originally he had an ulcer possibility through a moderately suggestive history. In this particular instance, however, the roentgenologist knew of the clinical history. He was consequently not satisfied with his own findings, especially his just questionable lower cap border, and asked to repeat his examination. One plate of the second series showed the only partially filled cap obtained with evidence of deformity and a small duodenal ulcer crater in the center of the cap area. The explanation of the apparently perfect cap was that the anterior duodenal wall was entirely uninvolved and ballooned out giving a practically perfect outline and concealing a posterior deformity. Such illustrations or others less striking are of daily occurrence in any considerable gastro-enterological service.

It may be questioned whether clinicians would welcome such relationship as that suggested. I cannot but feel, after many conversations with them, that such roentgenological consultation would be greatly appreciated, provided that all special and ethical qualifications were fully met. Certainly such relationships could be developed in hospital services and among groups. We have used the method in hospital and private practice for eight years with entire satisfaction. In

the case of hospital, clinical and private patients the history and laboratory findings and the clinician's impression as to possible diagnoses invariably accompany the patient at every examination, and frequently chiefs and residents come voluntarily or are sent word as the case merits personal discussion. The roentgenological consultant often suggests additional clinical examinations and as frequently states that roentgenological evidence is not definite and that clinical findings are best decisive.

You may take it as you will as to the opinion expressed. It has indeed not been easy to lay my personal convictions before you; but the facts confront us. It does not seem that the clinician will generally be superlative as his own roentgenologist. It does not seem that roentgenology under present arrangements is being quite as effectively utilized as it might be through limitation and intensive cultivation in association with clinical medicine. It does seem that in this direction may lie the future, the evolution of roentgenology—a state in which the roentgenologist will indeed be physician and consultant, a master and adviser. There can be no question that we have at our disposal the most powerful diagnostic weapon in medicine to-day, or any day; does it not behoove us to use it wisely in the interest of culture and service?

THE ANOMALOUS RELATION OF ROENTGENOLOGY TO MEDICAL PRACTICE*

By W. WARNER WATKINS, M.D.
Pathological Laboratory
PHOENIX, ARIZONA.

ROENTGENOLOGY, though firmly established as an art, has not won universal recognition as a specialty of medicine. Any man who confines himself to referred *x*-ray work will suffer daily humiliation in the knowledge that his work is not universally regarded as that of a specialist in medicine. This paper, in discussing some of the reasons for the failure to recognize roentgenology as a true specialty, will do so by attempting to answer four questions:

1. What is a medical specialty?
2. How does roentgenology fail to conform to the requirements of a medical specialty?
3. Is it possible for roentgenologists to win general recognition as specialists in medicine?
4. If so, by what means, in addition to those already employed by us?

First.—There are two classes of medical specialties.

(a) The true specialties are all cleavages from general medicine along purely anatomical lines. The American Medical Association recognizes the following specialties of this type: obstetrics, gynecology, orthopedics, proctology, ophthalmology, otology, laryngology, rhinology, urology, dermatology, pediatrics, neurology, psychiatry, internal medicine, tuberculosis. It is universally accepted that the specialists will become proficient in, and utilize, all remediable procedures applicable to their respective fields, whether the administration of drugs, use of physical and mechanical appliances or surgical operations. The ophthalmologist does not think of referring his cases requiring operation to a general surgeon, nor does the urologist refer his patient with a kidney stone to the surgical specialist. More usually the contrary procedure occurs. A very bitter and acrimonious discussion in a medical society over the ethics of a general surgeon's operating mastoid or tonsil cases is recalled,

*Read before the Pacific Section of THE AMERICAN ROENTGEN RAY SOCIETY, Catalina Island, California, June 17-19, 1920.

the claim being that the general surgeon should not enter the anatomical fields which have been marked out as specialties. The ophthalmologist, at least, has legal endorsement of such a contention, because one State Supreme Court assessed damages against a doctor in favor of a patient from whose eye he had removed a foreign body. Although the doctor was licensed to practice medicine and surgery, the court held that the patient should have been referred to the ophthalmologist. If we were legally recognized as specialists to this extent, such a decision would be in our favor; but in our present status the point of vital importance is that the anatomical specialists are universally recognized as entitled to employ any method of therapeutics or diagnosis. They have as much ethical and legal right to use the x-ray or radium as they have to employ cocaine or a knife.

(b) The specialties founded on proficiency in methods, instead of on anatomy, are those of anesthesia, bacteriology, pathology, public health, clinical pathology, roentgenology and surgery. Several of these are, at best, only quasi-specialties, without a fixed and recognized relation to medical practice. Our medical organizations still debate whether nurses should be received as accredited anesthetists, so that anesthesia certainly is not regarded as a medical specialty; bacteriology and pathology, like materia medica and chemistry, are teaching specialties, and can be practiced by non-medical individuals; public health, as a profession, does not require a medical degree; clinical pathology is an important part of medicine, but is not, by any means, recognized by organized medicine as a specialty. The only two remaining specialties of this group, roentgenology and surgery, can very properly be discussed together.

Second.—How far do roentgenology and surgery fail to conform to the requirements of medical specialties? The development of surgery as a specialized department of therapeutics, and the very similar development of roentgenology as a specialized method of diagnosis, and as an ultra-refinement of surgery, offers a very interesting field of study, which we have not space to elaborate. Surgical treatment began with Paré who would to-day be considered a quack, and for a long time was in the hands of non-medical individuals. After surgical methods had developed into importance, the art was appropriated by the medical profession and incorporated into their therapeutics. Note the significant fact that surgery, developed as a specialty outside of medicine, was assimilated in such a manner that it disappeared as a specialty, and has only reappeared as such after a tremendous struggle, which has not yet ended. Roentgenology parallels this evolution very closely. We can claim a more aristocratic origin, being indebted to the dignified science of physics, in contrast to the plebeian ancestors to which surgery must confess; and the applicability of roentgenology to medical practice was more quickly recognized, while its development as a medical method took place so rapidly that its non-medical origin is usually forgotten. Both surgery and roentgenology have become specialties under stress of circumstances, with a constant tendency to revert to the original conditions. Surgery became specialized when the applications of the art grew so numerous and when the knowledge and training necessary to maintain adeptness required so much that a doctor could not continue general practice and be a successful surgeon. The anatomical specialists have never yielded the right to operate their own surgical cases, and wherever a general practitioner is able to overcome the difficulties mentioned in a manner at all acceptable, he becomes his own surgeon. The first users of the x-rays were not specialists. When complicated machinery was developed, when the use of large numbers of temperamental gas tubes became necessary, when the scope of x-ray work began to demand detailed and time-consuming research work with the constant study of pathology by the entirely new method of shadow interpretation, the field of roentgenology was yielded to those who were willing

to work in it. Some communities accept the roentgenologist as a specialist; the American Medical Association allows us to classify ourselves as roentgenologists, but has never officially recognized the art as a medical specialty. We have gone one step farther than surgery, in that the anatomical specialties have yielded their fields to us. But that this concession on their part is regarded only as a loan of a talent to be developed by us and then returned, is witnessed by the alacrity with which the ophthalmologist, the dermatologist, the gynecologist, the internist, the surgeon, takes over the application of x-ray and radium the moment he can make such a move remunerative.

When we view the long struggle of surgery to establish itself as a specialty, we are convinced that this effort will succeed, at least so far as the general surgeon is concerned. But this recognition of a branch of therapeutics as a medical specialty will be won by sheer weight of numbers, and will need to be maintained by the Teutonic principle of "might makes right."

Third.—Is it possible for roentgenology to win from the general profession similar recognition as a specialty? It is certainly not to be expected that a new specialty, whose entire claim to recognition is based on proficiency in a new *method* of diagnosis or therapy, applicable to all the anatomical specialties, will be allowed to remain in our possession if it can be assimilated by the general medical body. If roentgenology and surgery succeed, they will represent the only successful attempts of many to establish specialties based on methods instead of anatomy. Hahnemann, the founder of a new method of therapeutics, was forced to start a new school of medicine in order to establish a specialty. The specialty of immunological therapeutics had a brief day and disappeared by absorption. Orthopedics, once based on the use of methods and appliances, had to be reorganized on an anatomical basis in order to prevent its total disintegration. Dietetics, hydrotherapy, electrotherapy, heliotherapy, can only flourish in the twilight zone of medicine, without any real standing as specialties.

Will roentgenology, from this day forward, gradually diminish in importance as a specialized form of medical practice, and eventually disappear as such? Or have we the inherent worth, sufficient numbers and staying powers, to capitalize our past achievements and duplicate the victory of surgery in establishing a medical specialty against precedent?

To these two questions no definite answer will be offered; but if you doubt the pertinence of such a discussion, I would say that this is an effort to crystallize the fears which have been expressed in every Roentgen Ray Society meeting I have attended for the last four years. Beginning with the oration of Dr. Hulst, in Chicago, in 1916, who said that our specialty was merely a preparatory one to develop methods which would be possible to every physician and surgeon, we have seen a gradually increasing drift toward the fulfillment of this prophecy. There is no need to elaborate instances, because all of you who practice in large cities know of specialists who are very proficient in the application of x-ray or radium to their limited fields. Let us not blind ourselves to the facts which are before us; remember that the world was nearly destroyed because of the inability of a great nation to see the plain facts which had been unfolding before its eyes for years. We cannot maintain our specialty even in its present unsatisfactory relation to medicine by resting on our past achievements. We must either disintegrate or develop our resources into something which has more *political* force and which cannot so easily be camouflaged.

Fourth.—How can we hold the field which we have won? Three factors have enabled us to develop our specialty to a high degree of efficiency; but efficiency has not, and will not, win us recognition from our medical brethren. If these three factors, or any two of them, can be overcome by the individual physician or surgeon, or group of such, the roentgenologist as a specialist will,

in all probability, be dispensed with by such individual or group. The three things which have worked in our favor, and still exert some influence, are (1) the machinery; (2) the pathological interpretation; (3) the time and cost of *x*-ray examinations or treatments. Just how permanent are these factors?

Simplification of machinery, apparatus and technique has been accomplished so rapidly that we have not been able to keep pace with it ourselves. With the self-rectifying tube and transformer of Coolidge, having the high tension discharge completely insulated by immersion in oil, it will not be unreasonable to expect diagnostic *x*-ray machines soon to be as common in doctors' offices as sphygmomanometers.

Roentgenologists must, of necessity, be highly specialized in disease pathology, with the additional ability to translate this knowledge from *x*-ray shadows into clinical terms. Just to the extent of this pathological knowledge and our ability so to translate it, depends our proficiency in our specialty, and we have a temporary protection in the monopoly which we have on such ability. But the masters of our art are teachers in medical schools throughout the land, and their eminent success is shown in their yearly product. The graduates of the past few years come into our laboratories and follow every move intelligently; they show an astonishing ability to interpret the pathology from the plates of their cases. They are a warning that the future generation of medical men can, if they choose, be independent of us. We must, therefore, constantly extend our field of work to keep pace with every advance in medicine, surgery and pathology. A close alliance between pathology and roentgenology is absolutely essential for our preservation.

The time element and cost element are, when all things are considered, still the most potent factors in the development of our specialty. The machinery has not yet become so simple that a doctor just starting practice can afford to operate his own *x*-ray laboratory, and the busier he becomes the less time will he have to devote to this time-consuming work. A surgeon cannot afford to spend an hour over a $25.00 *x*-ray examination, when he can be removing a $250.00 appendix which a consulting roentgenologist has definitely located where he can find it. However, both the time element and the interpretation of pathology are much less formidable barriers to the specialists with limited fields of work. While we are endeavoring to keep our art up with the general advances in medicine and surgery, we are very likely to find the specialists crowding us and demanding better results in their particular fields. If these results are not promptly forthcoming, they are very likely to undertake their own researches. This vulnerable point can only be protected by our giving better results, more quickly, and for less money than the specialists can secure for themselves.

In addition to closer attention to these factors, which have in the past permitted the development of our specialty, two other things are essential for our immediate protection and future development. These are efficient organization and universal propaganda. This paper has no space for elaboration of these very vital activities, and bare mention of them must suffice for now.

Roentgenologists are very indifferently organized at present. The society whose Western Section is here represented, although purporting to be the representative body of roentgenologists on this continent, contains fewer than twenty-five per cent of the accredited and qualified roentgenologists of the United States, and barely ten per cent of those west of the Mississippi. It would be unseemly in me to criticize our parent society, but it is proper to make the suggestion that we are in need of a more comprehensive organization, one with a fuller understanding of the needs of our specialty in its relation to general medicine. The man who enters this specialty in its present condition of undetermined status—legally at least—should have the backing of the most powerful organization, one not only supreme in its

scientific attainments, but one which can wield a potent political influence in the field of general medicine.

Such an influence is to be won by propaganda. Besides the failure to be sufficiently comprehensive in numbers, all of our roentgen ray societies deliberately plan and effectively maintain, a beautiful isolation from general medicine. It is small wonder that our professional parent will not own us as a legitimate child. Individual members of our specialty, realizing this fault, take their work before general medical and surgical bodies and secure individual recognition and reward, but our organizations are fearfully unresponsive to this crying need. As long as we can find fairly well-informed physicians telling patients that the x-ray is of no value except in fractures, as long as surgical societies will applaud the statement that radium never arrested a cervical cancer, as long as members of the American College of Surgeons will amputate the tongue for early cancer of that organ, as long as breasts are amputated in hospitals with x-ray departments, and the cancer allowed to recur without any thought of roentgen therapy, as long as patients are told (in candor) that exploratory surgery is the only way to diagnose gallstones, there is a need crying to high Heaven for our propaganda. To be effective, this should be directed by our organizations, should be persistent, should reach every county, state and national medical society, and should continue until there is universal recognition that our work requires medical men of the highest degree of specialism in disease pathology.

It is my personal belief that roentgenology, so far as the diagnostic use of x-ray is concerned, is due to be submerged in the larger field of clinical diagnosis. The practice of medicine at present rests on three cornerstones—diagnosis, medical treatment, surgical treatment. Clinical diagnosis is a specialty which is slowly evolving from several of the quasi-specialties previously mentioned—bacteriology, serology, pathology, clinical pathology, in conjunction with roentgenology, electrocardiography, etc. There is already more or less of a demand, which will increase with the complexities of medical practice, for a correlation of all methods of diagnosis into one specialty. It is entirely possible that such a field will be so large, especially in large cities, that it will need to be split into departments, of which roentgenology will be one. There are several excellent illustrations of roentgenologists engaged in such work. A notable one is that of a former president of The American Roentgen Ray Society, who practices the specialty of clinical diagnosis, utilizing x-ray interpretation simply as a part of his larger work.

Although such a development is largely a matter of the future, it is well worth considering whether our specialty will not find its ultimate and proper sphere by merging with other companion specialties to take possession of the coming field of clinical diagnosis.

THE ACTION OF BURIED TUBES OF RADIUM EMANATION UPON NORMAL AND NEOPLASTIC TISSUES

1. With Special Reference to the Therapeutic Dose in Experimental and Human Cancer.

By HALSEY J. BAGG, Ph.D.

From the Huntington Fund for Cancer Research, Memorial Hospital,

NEW YORK CITY

THIS investigation was undertaken to determine experimentally, by careful histological observation, the character of the changes produced in living tissues, both normal and neoplastic, by the radiations from very small glass tubes containing radium emanation buried in the tissues; and also to determine the area of effective radiation about the tubes.

This so-called "buried emanation" method had been in use at the Memorial Hospital for some time, when several questions arose concerning its use:

1. Is the effective area of radiation about the emanation tubes, i.e., the area in which the tumor cells were destined to undergo degenerative changes, the same for all practical therapeutic purposes for the tubes of 5 mc. strength (which was about the strongest tube used) as for tubes of half that strength, or even for a fraction of 1 mc.? This question is of considerable practical importance from the standpoint of determining the most economical and yet efficient use for the available radium.

2. Assuming the above question answered, and the practical dose determined, how far apart should the radium emanation tubes be placed to radiate efficiently a given mass of tumor tissue?

3. Do the various types of tissues exhibit about the same reaction to the same dose?

4. Do the clinical results show that properly distributed small doses of buried emanation produce the desired results with greater safety, and less pain and discomfort to the patient, than a comparatively large dose of radium per tube? And, in this connection, can tumor destruction be obtained without extensive sloughing?

EXPERIMENTAL METHODS

To answer these questions the problem was approached from three different angles: *First:* A large series of radium emanation tubes of different strengths, varying from 5.5 mc. to as low as 0.1 mc., were imbedded in normal rat tissues, in the muscles, subcutaneously in the testes, brain, and other parts of the body. *Second:* A series of rat tumors, the Flexner-Jobling rat carcinoma, was treated with radium tubes of different strengths. *Third:* With the cooperation of Dr. Harold Bailey, the conclusions obtained from the experimental work were tested upon several types of human cancer, from which cases careful clinical data gave an estimation of the practical value of the methods employed.

The tubes containing the radium emanation were cut from very fine glass capillary tubes.[1] They varied from 2.5 to 4 mm. in length, and were about 0.4 mm. in diameter, with containing walls about 0.1 mm. thick. The radium tubes were inserted in the tissues by means of a long steel trocar. The tubes were first placed near the sharply pointed end of the trocar, before it was discharged by pressure on the central plunger.

[1] The method of preparing the tubes has been described by Dr. William Duane in the *Boston Medical and Surgical Journal,* Dec. 1917. Mr. Gioacchino Failla, physicist to the Memorial Hospital, has recently constructed an apparatus for the uniform cutting of the radium emanation tubes.

The tubes and trocar are illustrated in Figure 1.[2]

In the experimental studies concerning the radium changes produced in normal animal tissues, the tubes were left in place from thirteen days to several months before the histological examinations were made. In treating the Flexner-Jobling rat carcinoma tubes were inserted in a wide range of living tissues—skin muscle, brain, testes, on bone surfaces, etc. The strength of the tubes varied from 5.5 to 0.1 mc. each, and the tissues were examined in from thirteen to sixty days. As a result of the histological study of the radiated tissues it was found that: (1) The immediate area about the tube was necrotic, an elliptical solid in shape, and about 5 mm. in diameter; and this change was practically uniform for the different amounts of radium that were used. The physical conditions bearing on this case will be taken up later in the discussion of results. (2) Beyond this area of necrosis was an irregular zone of tissue, from 2 to 3 mm. more, showing definite radium changes; edema, hypochromatism and karyorrhexis of nuclei, capillary congestion and extravasation of blood, with lymphocytic infiltration. The total area of tissue showing marked radium degeneration was about 1 cm. in diameter. Beyond this area the radium changes were ill-defined, and much less pronounced.

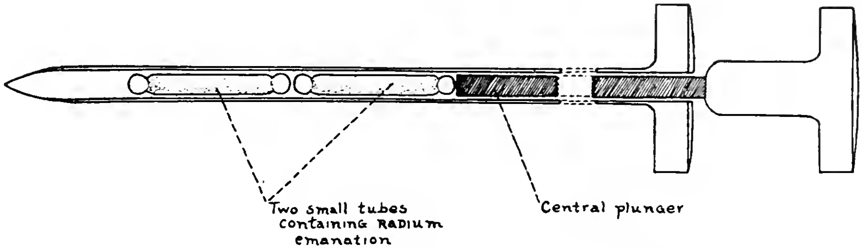


FIG. 1. SECTIONAL DIAGRAM OF TROCAR USED FOR THE INSERTION OF RADIUM TUBES. Two tubes are shown in position. Diameters x8.

the tissues were killed and examined at intervals from twenty-four hours to several days after the insertion of the tubes.

The tubes were located in aniline oil preparation, and drawings of the cleared sections were made before the tubes were removed from the tissue.

As a control to the above experiments, tubes recovered from previously treated tissues, and which had lost their radio-activity, were again inserted by the same technique into other living tissues. Any degenerative changes due to the traumatism incident to the insertion of the tubes would then act as a check on the comparative severity of tissue reaction in response to tubes with and without radio-activity.

EXPERIMENTAL RESULTS

SERIES A. *Buried Radium Emanation Tubes in Normal Rat Tissues.* Thirty-five

Plates I to V show the radium changes that occur in skin, muscle, testes and brain tissue.

On September 25, 1918, a radium tube containing 1.4 mc. was placed beneath the skin of a well grown, healthy, adult white rat, and the tissues were examined at the end of seventeen days. The treated area was widely excised and immediately placed in fixative. The histological changes are shown in Plate I. Surrounding the tube, for an area of about 4 mm., was a zone of necrosis, with a central softening of the tissues in the immediate proximity of the tube, which re-

[2] In treating human cancer, when the lesion is of considerable depth and somewhat inaccessible, as in the case of carcinoma of the prostate, in order to avoid unnecessary traumatism it is found convenient to insert several tubes at one time in a single trocar. To do this the tubes must be selected with an outside diameter slightly smaller than the lumen of the trocar; otherwise the tubes may overlap at their ends and jam within the instrument. By careful manipulation of the plunger, the tubes may be inserted at different levels of the growth.

sulted in sloughing at that point. As shown in the illustration, the central excavated area is longer in one direction than in the other, but this is due merely to the size and shape of the tube itself. For the sake of clearness the exact position of the tube has been indicated in ink on the photograph. Beyond the area just mentioned there is an additional zone showing marked edema, some exudate, and less severe degeneration of the tissues extending over a total area of about 1 square centimeter. Over most of this region the epidermis is eroded, and covered with dry scale containing pus. The results show that, roughly speaking, the volume of degenerated tissue in the immediate vicinity of the radium tube was 1 cubic centimeter. From a therapeutic point of view this is one of the main results of the investigation, since this condition appears to hold good for tubes between about 1 to 5 mc. in strength.

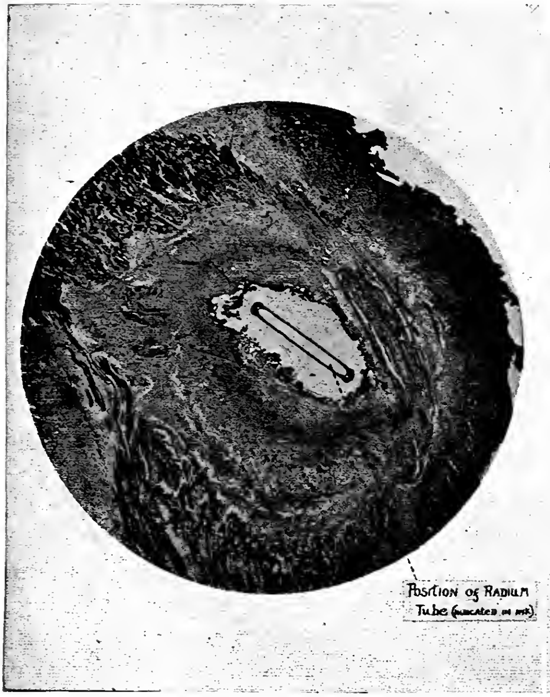


Plate I. Reaction from a Small Tube of Radium Emanation, Containing 1.4 millicuries, left under the Skin of a normal Rat for 17 days. There is a central area of necrosis,surrounded by a zone showing marked edema, and typical degeneration of tissues due to radiation. The area of destructive reaction is 1 cm. in diameter. the tube has been sketched in the photograph. Magnification, x14. (For further reference see text.)

Plate II. Radium Reaction from a Glass Tube Containing 0.4 millicuries, Inserted in the Leg Muscle of a Rat for 17 Days. The area of necrosis about the tube, plus an additional zone of degenerated muscle fibers, with lymphocytic infiltration, composed an area of definitely radiated tissue 9 mm. in diameter. The section was cut perpendicular to the axis of the radium tube. Magnification, x47. (For further reference see text.)

Plate II shows complete necrosis of muscle tissue in a rat's leg about a much weaker radium tube, 0.4 mc. This was also left in place for seventeen days. The section was cut nearly perpendicular to the axis of the radium tube, and the hole from which the tube was taken is indicated in the lower left hand corner of the photograph. Only the radiated tissue on one side of the tube is included in the illustration. There was complete necrosis of muscle tissue over a zone 4 mm. in diameter, surrounded by an area of edema, degeneration of muscle fibers, and lymphocytic infiltration over an additional zone, about 2.5 mm. in width. The total area

of radiated tissue in this case was about 9 mm. in diameter.

A still weaker radium tube, 0.2 mc., was placed in the center of a rat's testes and left there for twenty days. The histological picture is given in Plate III. The central area of necrosis was about 4 mm. in diameter. The peripheral portion of this zone showed

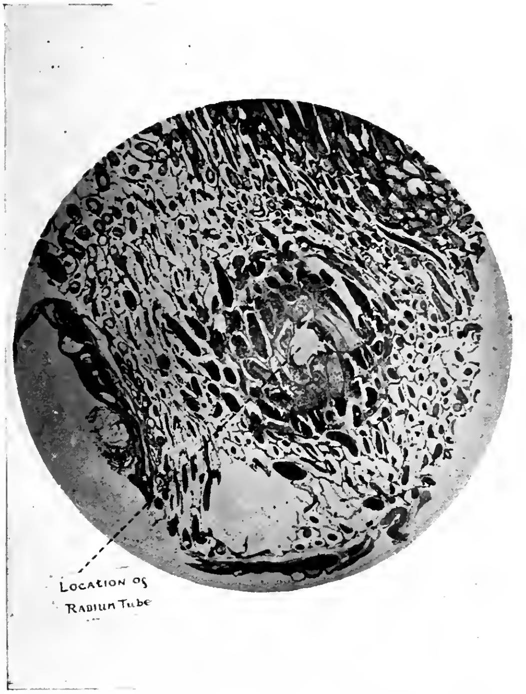


Plate III. Testes of a *Rat*, showing radium changes about a glass tube containing 0.2 millicuries, left in place for 20 days. The central necrotic zone is surrounded by an area of radiated tissue showing hypochromatism and karyorrhexis of nuclei; degeneration of tubule cells, edema, and capillary congestion. The total area of radiated tissue in this case was 8 mm. in diameter. The section was cut perpendicular to the axis of the tube. Magnification x16. (For further reference see text.)

hypochromatism and karyorrhexis of the nuclei of the seminiferous tubule cells. The surrounding zone, 1 to 2 mm. wide, showed edema, degeneration of tubule cells, and capillary congestion. The blood vessels of the entire testes were gorged with blood. In this case the total area of radiated tissue was about 8 mm. in diameter.

The histological material represented in Plates IV and V is not exactly comparable to the preceding sections, since the radium tube was separated from the tissues by the thickness of a rat's calvarium. The section is presented because it shows in a very striking manner the leukocytic infiltration which the tissues set up in an attempt to localize the irritant. The tube contained 1.2 mc. of ra-

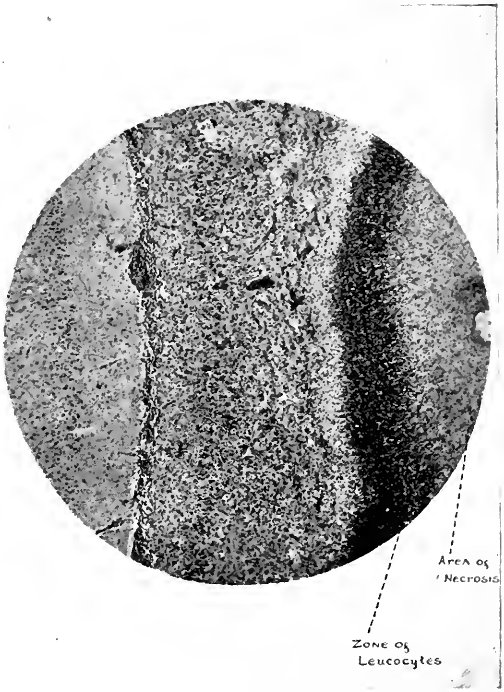


Plate IV. High Power Photograph of the Left, Middle Region of the Lesion Shown in Plate V, showing a portion of the area of necrosis at the right, the zone of leukocytes, and a wide area of hyperemia. Magnification, x60. (For further reference see text.)

dium emanation. It was placed under the scalp in the right cerebral region, and left there for 30 days. The scalp immediately above the tube was destroyed over an area of 8 by 10 mm. The brain lesion showed a central necrotic area, 4 by 5 mm. in diameter, which was sharply demarcated by a broad zone of polynuclear leukocytes, beyond which was a wide area of hyperemia and some pial-edema. The ganglian cells near the necrotic zone showed marked hydropic degeneration, and all the nuclei stained poorly. Some of the cells were completely broken up,

there were minute blood extravasations with some increase in the small compact nuclei in this area, and the neighboring pia showed marked round-cell infiltration. The cells of the adjoining convolutions showed chromatic bodies that did not stain well. There were pericellular and perivascular edema. The cerebellum appeared normal, but the

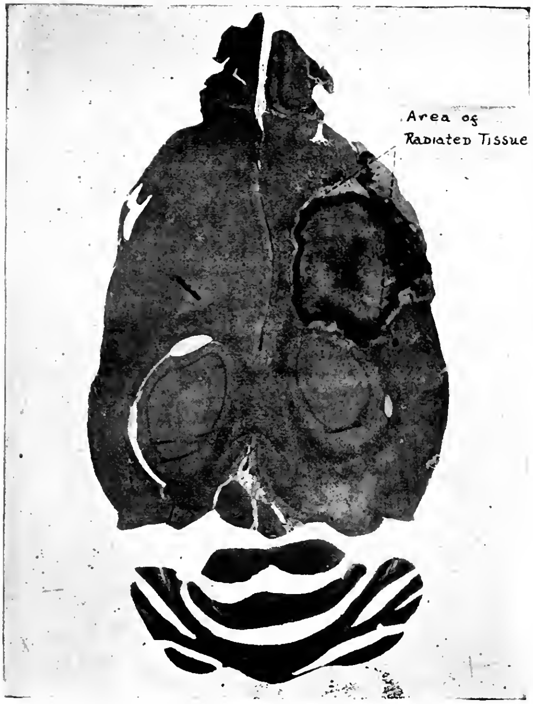


Plate V. Low Power Photograph of a Normal Rat's Brain, selected to show the marked leukocytic infiltration, tending to localize the effects of the radiation. A glass tube containing 1.2 millicuries was placed between the calvarium and scalp, and left in place for 30 days. Magnification, x8.5. (For further reference see text.)

chromatic bodies and Purkinji cells did not stain well. Plate IV shows a high power view of the periphery of the lesion, which extends beyond the mid-line of the brain.

Series B. *Buried Radium Emanation Tubes in Flexner-Jobling Rat Carcinoma.* Because of the rapidity with which the tumor cells respond to treatment, it was found more difficult to determine the area of radiated tissue about the radium tube in a growing tumor than in normal tissues. In some cases the tumor was promptly reduced in size, but again, attending inflammation and edema may be considerable, and although the actual amount of living tumor cells is reduced, the total bulk of tissue may appear increased.

To determine the radium changes that occur in the transplantable rat carcinoma, the

Plate VI. This is a lesion produced by a single radium emanation tube, containing about 2 millicuries, inserted in a carcinoma of the prostate; showing a central area of complete necrosis, with much leukocytic exudate, beyond which there are definite radium changes.

technique of Series A was followed; 30 radium tubes were inserted in tumors of different sizes, and the tests were divided into three groups: (1) The tumors were treated four weeks after transplantation, and the animals were killed at the end of one, two, four and seven days respectively. (2) Tumors were treated with small doses of radium, evenly distributed throughout the growth, and placed as nearly as possible 1 cm. distance apart. (3) Radium tubes of the same strength were placed in tumors,

but unevenly distributed, some of the tubes being more than 1 cm. apart.

Although these experiments are still being pursued, the results so far obtained are interesting enough to warrant their being mentioned here.

In the first group of cases no definite histological changes were noted in the tumors until two days after the insertion of the tubes. At that time an area of necrosis, 2 mm. in diameter, surrounded the tube, while the changes beyond this zone were indistinct, save for considerable edema, about 1 mm. away in the tumor capsule. In the case of the tumors examined one day after treatment, the radium tubes were inserted a slight distance beyond the growing peripheral area of tumor tissue into the necrotic center of the mass. No radium changes were noted in the surrounding tumor cells. Tumors examined seven days after treatment showed definite radium changes, and it is to be noted that it takes several days before this definite effect may be expected. In one case the tumor nodule, when selected for treatment, was slightly over 1 cm. in diameter. One tube of 0.3 mc. was inserted in the center of the mass, and seven days later the central area surrounding the tube was completely necrotic, and irregular necrosis extended throughout the tumor mass. The outlying cells showed marked hypertrophy and hyperchromatism of the nuclei, and many cell bodies were very large and markedly hydropic. This case showed an effective area of radiation of at least 1 cm. in diameter which was similar to the reaction in normal tissues.

In the second group, tumors have apparently disappeared after treatment with evenly distributed small doses of radium. A history of one case will serve as an example. A tumor was transplanted to a healthy, well-grown male rat on November 20, 1919. On December 30, the resulting tumor was a mass 2 cm. in diameter. It was treated at that time with 3 tubes of 0.3 mc. each, placed 1 cm. apart, and about 5 mm. below the surface. On January 7, the tumor was slightly reduced in size, and a small amount of exudate appeared on the surface. On January 23, the tumor was further reduced to two-thirds of the original size, and a small sinus, extending to the necrotic center, appeared on the surface of the growth. Evidently a good deal of the tumor mass was being discharged on the surface. On February 10, the cure might be said to be complete; the animal was in good physical condition, the tumor had completely disappeared, and on removal of the local scar no tumor tissue was found in the locality, or in any other part of the body. The tumor used was highly malignant, and one which early in its history metastasizes to the neighboring lymph nodes, the lungs, etc. Other tumor nodules of about the same size have given similar results; but the destroyed tumor cells were generally absorbed with no surface sloughing.

The third group of cases, i.e., those that were treated with similar small doses of radium, some of the tubes being placed more than 1 cm. distance apart and unevenly distributed throughout the growth, gave results that showed the ineffectiveness of this method. The tumors were not sufficiently radiated to control their growth, local repressions were noted about the tubes, but the outlying tumor cells retained their atypical properties, and in all cases the tumor process eventually resulted in the death of the animals.

Series C. *Control groups. Non-Radio-Active Radium Emanation Tubes in Living Tissues.* Radium emanation tubes were recovered from previously treated tissue and again inserted in living material. In all cases they were found to be practically inert, while the tissues adjacent to the tube showed none of the degenerative changes so typical in living tissues after exposures to radium. There was no evidence of hyperchromatism, capillary congestion, edema, etc.

Series D. *Buried Radium Emanation Tubes in Human Cancer.* Following the general principles determined from the experiments presented above, several cases of car-

cinoma of the vulva have been treated at the Memorial Hospital by Dr. Harold Bailey.[3] These were fairly well localized lesions, and the histological diagnosis was made by Dr. James Ewing.

So far this method of treatment has been extensively applied only to carcinoma of the vulva, and no claim is made for the practibility of the similar use of radium for different kinds of cancer in other anatomical situations; but we know at least that vulva carcinoma is one of the most fatally malignant, rapidly recurring types of cancer that the clinician has to deal with, and the possible control of this neoplasm would be encouraging from other standpoints. Operative procedures have been discouraging, not only because of prompt local recurrence after excision, but because of the rapidity with which metastases, apparently traumatic in origin, follow the rich chain of lymphatics situated in this region.

About ten cases of primary carcinoma have been treated by the methods described in this article. The lesions were in the vulvovaginal region, and in one case there was an involvement of the external urethral orifice. The lesions varied in size, from masses 6 by 5 cm. in area and 1 cm. in depth, to much smaller masses (2 by 1 cm.), which were fairly superficial. They were all treated with small glass tubes containing less than 1 mc. of radium emanation, distributed as nearly as possible 1 cm. distance apart throughout the growth. Generally tubes varying from 0.2 to 0.5 each were used.[4]

The results so far obtained have been rather striking, in so far that in severa cases, where the lesion has been treated wit weak doses evenly distributed, complete re gressions have resulted in the radiated area with practically no pain or discomfort to th patient, and with none of the disagreeabl sloughing of tissues, which so promptly fol lows relatively severe reactions.

It has been found difficult to obtain satis factory histological material showing local ized changes in carcinoma of the vulva, al though several attempts have been made t obtain small pieces of tissue for this purpose

In order to show the similarity in effec tiveness between radium changes in experi mental and human carcinoma, the writer ha selected the specimen shown in Plate VI This specimen was taken from the series o pathological slides at the Memorial Hospita which show localized effects from burie radium emanation.

Plate VI shows the area of radiatio about an emanation tube, about 2 mc. i strength, in carcinoma of the prostate. In th dense fibrous tissue between the prostati lobules is an area, about 5 mm. in diamete of complete necrosis, associated with muc leukocytic exudate. Over the entire sectio about 1.5 cm. in length, all the tissues show a peculiar, hyaline degeneration, and stai poorly. The epithelial cells lining many o the tubules are enormously distended by hy drops. This specimen shows that the local ized effect from buried radium emanatio is practically the same for carcinoma o the prostate, and for emanation in experi mental animal cancer, and normal anima tissues.

DISCUSSION OF RESULTS

So far as the writer has been able to ascer tain, Dr. William Duane was the first scien tist to appreciate the usefulness of buryin unfiltered tubes of radium emanation in tu mor tissue. He began his work on the prob lem in 1908 in Paris. In 1914, Joly and Stev enson reported their results from the use o similar methods in the *Proceedings of th Royal Dublin Society*, and the *British Medi*

[3] At present only a general account will be given of the usefulness of these methods in human therapy. With the cooperation of Dr. Bailey, the clinical data are being collected, and will be published in the near future.

[4] The glass tubes and needles were sterilized by boiling. If the neoplasm is situated in the proximity of bone tissue there is always the possibility of inadvertently breaking the delicate glass tubes during their insertion, and thus liberating the emanation before it can be of therapeutic value; but the tubes alone we have found to be inert, and recent experiments of the writer have shown that the radium emanation is so strongly bactericidal that the inside of the tubes are also sterile.

cal Journal.[5] And also at about this time, Dr. H. H. Janeway began to employ the method of buried emanation at the Memorial Hospital, where at the present it is one of the standard methods of treatment for certain types of cancer.

Projecting from a tube containing radium emanation, there is a spray of radiations in all directions, and although the alpha rays have very little penetrating power, and never succeed in getting beyond the glass walls of the tube itself, the beta and gamma rays pass through the glass and penetrate to various depths of tissue. Now, because of the relatively small penetrating power of the beta rays, they are absorbed to a large extent by a thin layer of tissue. The gamma rays pass beyond this zone and reach the outlying cells; but the dispersion of rays is increased the greater the distance from the source, so that the more distant gamma ray effect is comparatively slight, and less sharply defined than the beta ray effect. The area of radiated tissue does not increase in direct proportion to the amount of radium present; for if the radium is doubled the rays are not able to produce lethal effects twice as far into the tissues. When relatively strong tubes are used, the small depth of 5 mm. of tissue about the tube, i.e., 1 cm. in diameter, is radiated for a longer time than is necessary to produce the death of the cells, and we believe that in most cases this is not desirable.

The gamma ray effects, which occur farther away from the tube and appear later in time, are no doubt somewhat greater from relatively strong tubes, such as 5 mc., than from tubes of about 1 mc. each; but it has been difficult to test this point because of the prompt reduction in total size of any such treated tumor. It is possible that the tissues have a considerable amount of tolerance for the more penetrating radium radiations that reach beyond the 1 cm. zone, and this, together with the relatively small amount of radiation reaching this tissue, would account for the fact that there were but slight degenerative changes beyond the 1 cm. zone.

With comparatively large value tubes there is always the possibility of the tubes migrating during any sloughing that may occur, resulting in erosion of the walls of large blood vessels beyond the tumor proper, with attending hemorrhage; or the tubes may come to rest near some large nerve, and there set up a painful inflammatory process. This is of considerable importance when the lesion is in the neck or axillary regions, and a certain amount of motility of the parts tends to aid in the further displacement of the emanation tubes. This consideration is of especial significance in the treatment of carcinoma of the hollow viscera, stomach, bladder, etc., since the comparatively strong tubes, after causing a local slough, may be discharged by spasmodic muscular contractions at a time when they are still sufficiently radio-active to set up irritation elsewhere in normal tissue, and in the case of the stomach may result in violent prolonged vomiting; and in the bladder the misplaced tubes may injure the normal mucosa. In this connection, the use of comparatively weak radium tubes, i.e., those of 1 mc. and less in strength, has a distinct advantage, in so far as the tendency to slough out of position is greatly diminished; and if they are discharged after a few days they are not so likely to produce disagreeable effects in the normal tissues.[6] When one considers the fact that these tubes have an average life of 132 hours,[7] it will be seen that even when using

[5] Joly and Stevenson. *Proc. Roy. Dublin Soc.*, May 8, 1914. *Brit. M. J.*, July 4, 1914.

[6] The writer was interested in noting that Dr. Robert M. Lewis of Baltimore, who recently reported his methods for the insertion of unfiltered radium emanation, mentioned the fact that he was still using radium tubes of 2 and 5 mc. strength. (R. M. Lewis. *Surg., Gynec., and Obst.*, xxx, May, 1920.)

[7] The 132 hours is a mathematical factor, which when multiplied by the number of millicuries, gives the mc. hrs. of total irradiation. Thus if a tube of 0.5 mc. is inserted in the tissues the total dose of radium which is given is $0.5 \times 132 = 66.0$ mc. hrs. It should be noted, however, that the same dose in millicurie hours of a larger amount of radium for a correspondingly short length of time, will give a much more violent reaction.

tubes of less than 1 mc. strength, the tissues received a considerable amount of radiation.

CONCLUSIONS

1. These experiments have definitely indicated the therapeutic advantage of the treatment of certain cancers by means of small unfiltered glass tubes containing relatively little radium emanation per tube.

2. Less than 1 mc. is a satisfactory dose; in fact, 0.5 mc. per tube was found to be a most advantageous amount to use. When only a small supply of radium is available this is of considerable practical importance.

3. In order to treat effectively a given mass of tumor tissue with an even distribution of radiation, the emanation tubes should be imbedded about 1 cm. distance apart.

4. Interesting histological changes have been noted; and of especial interest was the presence of a pronounced leuffocytic infiltration, which tended to wall off the necrotic area about the emanation tubes.

ACKNOWLEDGEMENTS

The writer wishes to acknowledge his indebtedness to Dr. James Ewing for assistance in the interpretation of the pathological results. Thanks are also due to Dr. H. H. Janeway for suggesting certain phases of the problem; and to Mr. Failla for advice concerning the physical considerations.

THE X-RAYS IN THE TREATMENT OF FIBROMATA AND UTERINE HEMORRHAGES*

By J. E. PANNETON, M.D.

MONTREAL, CANADA

Translated by Lowell S. Goin, M.D.

THE value of roentgenotherapy in the conservative treatment of uterine fibromyomata and of uterine hemorrhages is to-day well established and universally recognized. It constitutes, in fact, the treatment of election in these two pathological conditions, provided that there exist no infectious or cystic complications and that there is no accompanying disease of the adnexa.

This question of the roentgenotherapy of uterine fibromyomata has excited a great deal of discussion. Some over-enthusiastic roentgenologists believe that in the *x*-ray method is found a unique and unequalled treatment for all uterine fibromata, while others admit that surgery is suited to a few exceptional cases, and to cases where, for particular reasons, it is not convenient to administer roentgenotherapy. On the other hand, many eminent surgeons refuse to recognize the success of roentgenotherapy, relegating it to the groups of simple palliative measures already well known. The truth lies in a modification of these opinions, each of the two processes having its advantages. It is necessary first of all to be able to weigh the indications.

Surgical intervention will ever remain the treatment of choice in dealing with very large tumors which may give rise to grave pressure symptoms, tumors of rapid growth, pedunculated tumors, tumors complicated by cystic or inflammatory lesions of the adnexa, or those undergoing a process of malignant degeneration.

Roentgenotherapy is employed most successfully in the following cases:

1. In small, simple fibromata characterized only by a sensation of weight or fatigue in the lower abdomen, with menorrhagia.

2. In large fibromata, palpable through the abdominal wall, rising perhaps as high as the umbilicus, and accompanied by such symptoms as mechanical type of *constipation*, very difficult to overcome, due to pressure on the iliac colon; *frequent micturition,*

*Thesis presented with application for membership in THE AMERICAN ROENTGEN RAY SOCIETY.

due to diminution, by pressure, of the capacity of the bladder; *lumbar and sciatic* pain, due to pressure on the lumbar and sacral flexures. The menstrual periods may be normal as to the amount of flow and duration, or may be slightly increased in both.

3. In fibromata of any size accompanied by more or less severe hemorrhage.

4. In uterine hemorrhages of non-infectious origin, and in certain painful menorrhagias, without demonstrable fibroids.

5. In uterine hemorrhages with subinvolution, or in the hemorrhages preceding a delayed menopause.

In all of these cases, the results obtained are such as to be best represented by the words "cure," or "clinical cure," provided that the dose administered has been considerably more than that actually necessary to produce the menopause.

Very numerous observations have been published. I will not recall them here (their simple enumeration would require too much space); but shall content myself with citing the conclusions of some of their authors. In October, 1913, in the *Archives d'Electricité Médicale*, Dr. A. Béclère, the eminent roentgenologist of the Hôpital St. Antoine, Paris, published some remarkable statistics including 66 cases. "My statistics," he says, "are very favorable, showing success in 96 to 97 per cent of the cases; but I am far from attributing any merit to myself. The principal factor of success arises from the fact that the majority of these cases were referred to me by such gynecologists as Bar, Champetier de Ribes, Labadie, Lagrace, Lepafe, Pinard, Ribemont Dessaignes, and Siredey, or by such surgeons as J. L. Faure, Gosset, Perier, Ricard, Rochard, and Roux. In each case it was after a careful study of the therapeutic indications and contraindications that roentgenotherapy was judged preferable to surgical intervention."

In their conclusions, Bergonie and Speder write: "In the treatment of fibromata, the first noticeable modification of the menses and the hemorrhages was observed in less than two months of radiation. The menstrual periods become normal at once, then their duration and their amount decrease. After three or four series of radiation, rarely five, the menses and the hemorrhages cease.

"The fibromata always decrease in size, but in various degrees. In certain cases we have observed the complete disappearance of the tumor; in others, where an enormous tumor rose above the umbilicus, it diminished to two or three finger-breadths above the pubis, where it remained, unaffected by further treatment. The general condition is improved, the anemia ceases, the phenomena of compression disappear and the patients take up their occupations and their daily lives without the slightest discomfort.

"Roentgenotherapy presents not the least danger; with proper technique, the employment of the proper quality of rays, and a sufficient interval between the series, there is no danger of injuring the skin."

Bordier says: "Roentgenotherapy gives results which no radical method, electrical or otherwise, has ever afforded. But I hasten to add that if one follows a poor technique, one will obtain no better results than with other medical methods."

Insisting on the necessity of proper technique, Bordier adds that "it is so important that it is the dominant factor in the roentgen treatment of fibromyomata." This technique owes its success to three principal factors:

1. The judicious choice of the bundle of rays employed.

2. The measurement of the dosage.

3. The quality of rays emitted by the tube.

Are all women equally sensitive to roentgenotherapy? Until recently, roentgenotherapy was advised only for women who had reached or passed the menopause, that is to say, women aged forty or more. Younger women may have occasionally derived benefit from x-ray treatment, provided that it was continued long enough, and in an intermittent manner. But it is possible to-day, thanks to new technique, to induce the menopause artificially in young women seventeen

to eighteen years of age, or even in young girls at puberty, if there is a therapeutic indication for it.

It must be noted, however, that the treatment of young women is necessarily more prolonged than that of older women, the time required being in inverse proportion to the age of the patient. It is also necessary to warn young women that roentgenotherapy may produce in them a more or less definite sterility.

More than four years ago, at the Notre-Dame Hospital, I treated a young woman, aged twenty-five, who had a small hemorrhagic fibroid. Her menstrual periods were so painful that she was often obliged to remain in bed. An operation was advised, but was persistently refused. Her doctor, who was treating her for certain nervous troubles, induced partly by her gynecological condition, referred her to me. Under roentgenotherapy the hemorrhage subsided rapidly, and her menstrual periods ceased. The fibroma disappeared completely. I have seen this patient at regular intervals, in order to follow the results of the treatment. After twenty-seven months of menopause, she had a normal menstruation, and three months later, a second. Except for a few "hot flashes" during the first weeks, the patient experienced no symptoms attributable to this artificial and probably definite menopause.

One often encounters the following objection: "Don't you believe that there may be some danger in leaving *in situ* a uterus thus atrophied or sclerosed? Don't you think that later it may develop into a cancer?" This question arises from a theoretical fear which may be legitimate in itself, but which, nevertheless, remains hypothetical. Personally, I have never known of a case of uterine cancer developing after roentgen treatment for fibromyomata. If the cancer existed before the treatment, either alone or as a complication of the fibroma, we have seen that surgical intervention was indicated, leaving the x-ray to be employed as an adjuvant. Whenever and wherever I have met an experienced roentgenologist, I have never failed to put this question to him, and the reply has always been in the negative. Meanwhile, the first cases of roentgenotherapy for uterine fibroids date back seventeen or eighteen years in Europe, and I have before me a report by Dr. J. E. Hett of Berlin (Kitchener), Ontario, of a patient treated in January, 1903 (seventeen years), and published in September, 1904, in the *Journal of Advanced Therapeutics,* having for title: "The Complete Absorption of a Large Uterine Fibroid by X-Rays."

This danger, while remaining rare and remote, would be largely compensated, even if it existed, by the numerous advantages which this conservative method offers over surgical intervention.

What, then, are the principal advantages of roentgenotherapy when it is indicated?

1. The elimination of what risks there may be from an anesthetic. Roentgenotherapy, in fact, contrary to the process of electrolysis (method of Apostoli) is so absolutely painless that the patient is always astonished to learn that the treatment is finished.

2. The elimination of the possibility of post-operative hernia, internal hemorrhages, suppuration, or adhesions necessitating a second operation.

3. The patient loses no time by being bedfast, the treatment demanding only a few minutes every three or four weeks. In the intervals between the series, she may attend to all of her ordinary duties, and she has no need of special care.

4. One does not find in women treated by the x-rays that peculiar psychic or mental condition, nervous perhaps, observed after removal of the uterus or ovaries.

5. Roentgenotherapy offers absolutely no danger of roentgen dermatitis or ulceration, if a proper technique is employed.

6. Finally—and this is not the least of its advantages—roentgenotherapy has no mortality percentage.

It is objected that roentgenotherapy, although a sure method when indicated, is a little slow, and that surgery cures the patient much more promptly. When the patient leaves the operating room she has no

fibroma, it is true, and if she were not obliged to "recover from her operation," we should be forced to admit that surgery is more rapid; but if one takes into account the three or four weeks of hospitalization, and the weeks of rest and recuperation at home, supposing everything to go well (for in case of complications the time must be counted in months), the advantage remains with roentgenotherapy, which neither hospitalizes nor weakens its patients. This last advantage is more appreciable in the case of women who, because of their domestic obligations, would be unable to take a complete rest for several weeks.

My own statistics include forty-four cases. Seven of these were large tumors, with profuse and frequent hemorrhages, incapacitating and exsanguinating the patients. The ages varied from thirty-seven to fifty-five years. The tumor disappeared completely in the majority of these cases; in the others the reduction was incomplete, but nevertheless sufficient to suppress all of the disagreeable clinical symptoms in from three to six months. There was a complete cessation of hemorrhages and the establishment of a definite menopause in all of these cases except one, in which special circumstances forbade the continuance of the treatment. This case had hemorrhages of such gravity that it was necessary to administer, before the x-ray treatment, an injection of a coagulating serum. A second injection being attended by grave anaphylactic symptoms, it was necessary to suspend temporarily the roentgenotherapy. The patient was without hemorrhages for six weeks, but as she refused to remain in the Notre-Dame Hospital, and as she was obliged to remain in bed, she was unable to receive the roentgenotherapeutic applications which, without the least doubt, would have established the menopause. At the end of six weeks, she had a copious hemorrhage, and underwent an emergency operation. At the operation there was removed a large classical fibromyoma, exactly of the sort best treated by the x-ray. Twenty-two of my cases were those having habitually profuse menstruations, and occasional alarming hemorrhages. The size of the tumor varied from about the size of an orange to one large enough to rise to the umbilicus. The ages varied from twenty-five to sixty. In twenty cases the treatment produced a definite menopause, with no later return of the menstrual function; in one case menstruation reappeared twice, the first time after twenty-seven months, the second three months later. This case would seem to indicate that the menses may return in young women, if the dose administered was just sufficient to allay the principal symptoms. In seventeen cases the fibromata disappeared completely. In four cases there was a considerable decrease in the size of the tumor, and the patients remained symptom-free.

One of these last cases was that of a young woman, aged thirty-three. She was referred to us, with the diagnosis of fibroma, by her family physician. The diagnosis was confirmed by an eminent surgeon, who advised operation. The patient presented a large mass in the right iliac fossa, palpable in the vagina. She complained of pain low in the abdomen. Her menstrual periods were of long duration, profuse and frequent, occurring every three or four weeks. By advice of her physician, we commenced roentgenotherapy, but after the fourth application we discovered the tumor was growing. We advised her to consult a surgeon, and to undergo an operation if he thought it advisable. At operation there was discovered a fibromyoma complicated by an ovarian cyst, and a small dead fetus. If the diagnosis had been made correctly we would not have treated this patient, as roentgenotherapy was contraindicated.

Six cases were those having more or less normal menstrual periods. The principal symptom was pain in the lower abdomen, increased at the time of menstruation. The tumors varied in size from the size of an orange to that of a child's head. The ages were from thirty-four to forty-nine. The treatment produced definite suppression of the menses in all the cases, complete disappearance of the tumor in the majority of them, and a considerable decrease in the size of the

growth, accompanied by relief from all symptoms in the remainder.

Two were large fibromata in women who had no menorrhagia, one being eleven years and the other four years past the menopause. The first patient, aged fifty-nine, had a very large fibroid which, because of its great mobility, was believed to be pedunculated. She insisted on being treated by the *x*-ray, in spite of my advice to undergo a surgical operation; but as her condition was no better after three series of treatments, I abandoned the treatment. The second patient, aged forty-eight, had had no menorrhagic losses for four years. Her tumor rose a hand's breadth above the pubic bone. Under roentgenotherapy the growth disappeared behind the pubes, and although the uterus remained a little enlarged, all the painful symptoms vanished.

Two cases were women with large subinvoluted uteri, who were suffering profuse hemorrhages. No fibromata could be demonstrated. Roentgen treatment produced the menopause in each case.

Five cases were women having hemorrhages, whose uteri, however, were apparently normal in size. Roentgenotherapy produced a definite menopause in four cases. In the fifth case, that of a woman of forty, the menses ceased and the nearly intolerable pains disappeared after five series. For economic reasons she thought herself obliged to discontinue the treatment somewhat prematurely. The patient had neither menses nor pain for five months, and congratulated herself on having attained the menopause with a minimum of radiation. But after five months, a painless menstruation occurred, which decided the patient to receive another application. We warned her that she could not hope to obtain a definite menopause with less than 8 or 9 series, especially since she had suspended treatment for several months. She refused to submit to longer treatment, however, and after the appearance of another menstruation, two months later, she concluded that the method was a failure. I cannot agree that this case is a failure. On the contrary, the prompt cessation of the menses and the relief from pain during five months, after five applications, is in reality, a notable success. I have not the least doubt that two or three further applications would have produced a definite menopause in this case as in the four other cases of this series.

I have excluded from these statistics the case of a woman, single, aged forty, who was referred to me by her family physician in November, 1917, with the diagnosis of a large uterine fibroma. The patient presented a large hard tumor rising to the height of three finger breadths above the umbilicus, and somewhat more developed on the left side. She had very marked pain in the legs and an obstinate constipation, but neither urinary symptoms nor hemorrhages. The correctness of the diagnosis seemed doubtful to me at the time; but guided as much by professional courtesy as by the fear of the always possible error, I refrained from communicating my doubts to the patient, and I administered three series of treatments, which had no apparent effect upon the tumor. I referred the patient back to her physician, calling the attention of the latter to the probability of the tumor being a large cyst of the ovary. The doctor, concurring in this opinion, advised operation, which was obstinately refused, and the cyst was finally emptied by abdominal puncture. The greater part of the mass now disappeared, but another hard tumor could still be palpated in the right iliac fossa. The doctor was convinced that this time we had to deal with a fibroma, and again advised treatment by the *x*-ray. The first series was given the 23rd of February, 1918. On March 30th, the patient presented herself for the second series, and I found that the tumor had completely disappeared. By April 26th, the tumor had returned to approximately its volume of February 23rd. On May 24th the fourth series was given, apparently without influence on the tumor, from which I concluded that doubtless we had to deal with a second cyst, and I advised the patient to undergo an operation, as roentgenotherapy had not the least chance to effect a cure. To this she consented and at operation a rather large ovarian cyst

was found. The uterus was apparently normal, showing no trace of the fibroma.

My personal statistics are thus shown to be in perfect agreement with those of our masters. We find from them that the symptom of hemorrhage, the most alarming to the patient, and usually the symptom that decides her to consult a physician, disappears unfailingly provided that the dose of radiation absorbed has been sufficient.

As to fibromata, they disappear completely in the great majority of cases. In the other cases they undergo a well marked retrogression which is nearly always sufficient to cause the disappearance of all the symptoms of pain and of compression of the intestines and bladder.

In the 44 cases which I have presented, 41 were clinical cures and 3 were failures; that is to say, 93 per cent of success. Two of the failures were due to a diagnostic error, the third failure should be imputed to the patient rather than to roentgenotherapy, since the patient, after the treatment advised in 1915, did not call upon me until a year later when she was literally dying of hemorrhage. After the third series of treatments she experienced relief from all symptoms for six weeks, and had she been willing to remain in the hospital and to have received at least three more applications, she would have been freed, I am certain, from the danger of further uterine hemorrhage.

I feel convinced that we may be assured of a brilliant result in every case where the diagnosis has been made correctly.

Personally, I feel so assured as to the results to be obtained that if the patient does not experience a marked improvement after the third or fourth series I do not hesitate to affirm that the diagnosis is incorrect and that it is not a case of fibroma, or that, if the fibroma is present, there are at the same time adnexal complications which can be cured only by surgical intervention, and I do not hesitate to refer those patients for surgery.

INFLAMMATORY LESIONS OF THE ADNEXA

Radiotherapy is ordinarily contraindicated in inflammatory lesions of the tubes or ovaries.

I have, however, made an interesting observation on a patient seen in consultation with a surgeon in September, 1913, which is worth relating here.

The case is that of a young woman, twenty-seven years of age, having suffered profuse and painful menstruation for two or three years. There was no history of a Neisserian infection. For some months the pains had been very persistent in the right iliac fossa, even between the menstrual periods. On the day that I saw the patient with her surgeon she was unable to leave her bed, was suffering considerably, and had a temperature of 102 degrees. The right iliac fossa was very tender and felt very hot to the touch. Vaginal examination revealed a hard painful mass in the right side. The diagnosis lay between appendicitis and adnexal lesion. However that may be, rest in bed, and ice applied to right iliac region, lowered the temperature and relieved the pain in a few days.

At the end of fifteen days the patient was much better, except for slight tenderness in the right side. Vaginal examination at this time revealed a large fluctuating mass in the cul-de-sac of Douglas. There was no temperature. There was slight tenderness and some heaviness in the right iliac fossa; operation was advised but was refused. At the patient's menstrual period all the symptoms returned, temperature rising to 100 degrees and subsiding again after ten days.

The patient persisted in refusing an operation and demanded that she be treated by roentgenotherapy. I warned her that there was considerable risk of re-exciting the acute symptoms, but she insisted nevertheless. Ten days after the first application all the patient's pain had disappeared and she felt as though the discomfort which existed in her right side were vanishing. The second application relieved the pain completely, even palpation becoming painless. The menstrual periods following, to the patient's great surprise, were practically painless and lasted only four days. Two other series were given

at intervals of fifteen days, at the end of which time the patient declared she had never felt better. The third vaginal examination revealed, to the great surprise of the surgeon, that the cul-de-sac was entirely free and that there was no tenderness whatever in that region. In short, everything seemed to him to be absolutely normal.

As I did not wish to produce an amenorrhea, I suspended the radiotherapy, keeping the patient under observation. The four menstrual periods following were normal, painless and regular. The fifth period was somewhat premature, more profuse, and rather painful. The sixth period was very painful and the right iliac fossa again became tender. Roentgen treatment was resumed; I made four applications at intervals of three weeks. After the first application, the pain ceased, and for the year following the patient had regular and painless menstrual periods. Then, following a prolonged exposure to inclement weather, the patient had two painful periods. Four more series of roentgenotherapy were given, and for two and a half years the patient has experienced no sort of pain in spite of frequent exposure to all sorts of inclement weather. It is worthy of note that three or four times a year the patient misses a menstrual period, having in its place, "hot flashes." It is quite probable that in this case the right ovary is sterilized.

I do not wish to draw, from this single observation, any conclusion as to the value of radiotherapy in inflammatory lesions of the adnexa. I say adnexa, because I believe that the entire clinical history of this case points to disease of the adnexa rather than of the appendix. I believe it would be very interesting and well worth while to repeat this experiment in a case where, for some reason, operation was contraindicated.

The continuation of the menses in a person who has reached the age of the normal menopause may have a considerable reflex influence on some other pathological condition, as, for example, a nephritis or a disease of the stomach or heart where such is sufficient to render useless all our therapeutic efforts and endanger the life of the patient. In such cases the production of an artificial menopause may be considered as indicated.

The following case will serve as an illustration: Miss M., age forty-eight, suffering from a serious cardiac disease, was referred to us by her doctor. Orthodiagraphy showed a cardiac shadow measuring 128 square centimeters; an increase in area of about 50 per cent. The usual treatment for such conditions was effective in the intervals between the menstrual periods, but at the appearance of the menses the heart would become uncontrollable and the patient's condition would grow very serious. This condition of things existed for many years and the establishment of the menopause, which was expected to relieve these symptoms, was anxiously awaited. The menses reappeared, however, with disheartening persistency, each reappearance being a new menace to the patient's cardiac condition.

Roentgenotherapy was proposed and tried. A single application of the *x*-ray served to arrest menstruation and the patient experienced such a condition of well-being that she insisted on receiving several more treatments in order that the menopause might be definitely established.

The patient is still a cardiac patient, but the means of combating the symptoms of her affection have acquired a new efficacy.

These observations would seem to imply that in the *x*-ray we possess a method of incontestable efficacy for the treatment for some of the diseases of women.

I cannot better conclude this summary than to quote the conclusions of a physician of thirty years' experience. In his inaugural address given December 13, 1917, before the North London Medical Society, Sir John Phillips, M.A., M.D., F.R.C.P., Surgeon to the Queen of England, Professor Emeritus of Obstetrics at the Royal College, said: "All varieties of fibromata correctly diagnosed as such may be successfully treated by the roentgen ray. I may say that my personal conviction is, that we have in the *x*-ray

a very powerful therapeutic agent which promises to be of an inestimable value in the treatment of the diseases of women."

TECHNIQUE

In the great majority of cases I have employed the technique described by Dr. Béclère; that is, the radiation of the two ovarian regions, directing the rays obliquely through the uterus, using only two anterior ports of entry. In women more than forty years old the arrest of the hemorrhage and of the menstrual function was obtained after the third or fourth application, parallel gap of 20 to 22 cm.; three millimeters of aluminum for filtration; radiant energy equivalent to 16 X. In women fifty years of age such a dose produced the menopause; in one case after the first treatment, and in three cases after the second treatment. In younger women aged from thirty to forty years, the menopause was not established until after the fifth, sixth or even the seventh application.

As to fibromata, the number of applications required to make them disappear varied from five to ten series, according to their size and age. The majority of these tumors disappeared entirely; in certain cases the uterus was found to remain a little enlarged.

In the cases of very large tumors, some of them disappeared completely; seven or eight underwent retrogression to such a degree that they disappeared behind the pubis, the uterus remaining somewhat enlarged. The patients, however, complained of no discomfort and were clinically cured.

One case of a large pedunculated fibroid seemed to be quite unaffected by radiotherapy, and the treatment was abandoned.

In some cases where it seemed desirable to produce prompt results, either because of the abundant hemorrhages or to avoid obliging patients in the country to make such frequent visits to my office, I have used four ports of entry, two anterior and two posterior. The effects have been much more rapid in these cases. The intervals between the series were three, four and five; in some grave cases the first application was repeated in 15 days.

Finally, in some cases, I have tried the method of multiple port of entry; eight anterior and eight posterior. It did not seem to me that I obtained the menopause any more rapidly by this procedure than by the method of Béclère, which is much more simple. On the contrary, with this method of several ports of entry, I have noticed that the patient experienced malaise, vertigo, nausea or even vomiting from the first series of applications, and that these symptoms are much more marked and more annoying to the patient than those occurring with the simple method of two ports of entry. In fact, with this last technique several patients experienced either no discomfort, or symptoms so mild that it was necessary to inquire about them before the patient thought of them. The majority of women, however, complain of vertigo and nausea after the third or fourth application. These symptoms increase in intensity with the number of successive applications, but except in one case they have not been sufficient to justify the cessation of treatment. Moreover, for two years I have confined myself entirely to this simple and efficacious method of two anterior ports of entry, which seems to offer the minimum of inconvenience.

In serious cases where immediate action is indicated I do not hesitate to give a dose of 30 or even 40 X with excellent effect upon the hemorrhage; but in these cases the general symptoms have been more marked.

The results obtained have been permanent, the earlier cases dating back eight years.

With thick filters the effect on the skin is nil; I have never observed telangiectasis. Some of my first cases which were treated with a 1 mm. filter of aluminum and with a parallel gap of 15 cm. have insignificant telangiectases, but no case has presented any induration or ulceration of the skin.

THE RATIONALE OF RADIUMTHERAPY IN CANCER*

By ISAAC LEVIN, M.D.

Department of Cancer Research of the Montefiore Hospital and Home.

NEW YORK CITY.

THE SPECIFICITY OF THE BIOLOGICAL ACTION OF RADIUM.

THE terms "selective action" and "selective absorption" are being employed more or less promiscuously in defining the peculiar influence which the x-rays and radium exert on plant and animal cells. In reality, the two terms imply different phenomena in the interaction between the rays and the cells.

The fact is well established that the biological effect of the rays on plant and vertebrate animal organisms differ within the various tissues. While the spermatozoa-forming epithelium and the Graafian follicles, for instance, are extremely sensitive to the rays, nerve tissue and the structures of the eye are highly resistant.

The cells most sensitive to the action of radium and x-ray are the leukocytes, and these cells present the most favorable material for the study of the "selective action" of the rays.

In a case of lymphatic leukemia with an initial leukocyte count of 226000, an enlarged spleen without any enlargement of the lymph glands, the writer made two applications of radium to the spleen within a week, 2016 millicurie-hours in all. The leukocyte count came down to 12000 and the spleen diminished to a half of the original size.

Figures 1 and 2 show the blood pictures before and after radium applications to the spleen of another case of lymphatic leukemia. In this case there were large lymph glands in the axilla and the spleen reached below the umbilicus. After radium treatment the spleen and glands diminished in size and the leukocyte count went down from 180000 to 50000.

This rapid destruction of a specialized tissue by an external application of radium to the spleen which was not followed by even an erythema of the skin in the field of application, presents a remarkable biological phenomenon indeed.

The "selective" biological action of radium goes beyond the apparent structural differences of the cells. The lymphocytes of lymphatic leukemia and those of conditions of inflammatory leukocytosis are morphologically identical. None the less, radium destroys rapidly the former and has a comparatively slight effect on the latter. The same difference may be noted, for instance, between a lymphosarcoma of a lymph gland and a tubercular lymphoma. The latter condition is influenced by radium with much greater difficulty than the former.

Another proof of the remarkably fine adjustment of the "specific action" of the rays on cells was obtained by the writer in the course of a study of the blood of cases of skeletal metastases of carcinoma treated with radiations.

Radium and x-rays reduce rapidly the number of myelocytes in the blood of cases of myelogenous leukemia. The blood of cases of skeletal metastases of carcinoma also frequently contains an increased number of myelocytes in the blood. These latter myelocytes are not influenced by the rays, though they are morphologically identical with the myelocytes in myelogenous leukemia. The explanation of this phenomenon lies in the fact that the two types of myelocytes differ biologically. The myelocytes in myelogenous leukemia, as well as the lymphocytes in lymphatic leukemia, are analogous to cancer cells. They are young, rapidly proliferating cells and therefore highly sensitive to the rays. The lymphocytes in inflamma-

* Read by invitation at the twenty-first Annual Meeting of THE AMERICAN ROENTGEN RAY SOCIETY, Minneapolis, Minn., September 14-17, 1920.

tory leukocytosis and the myelocytes in the blood of skeletal metastases are more mature cells; they do not proliferate so rapidly and are therefore more resistant to the rays. Thus the term "selective action," means that *the identical rays act differently on different tissues.*

On the other hand, there is ample clinical evidence of the fact that rays of a different quality affect differently the same type of tissue. For instance, soft x-rays and alpha rays of radium act differently on the skin from the hard x-rays and the gamma rays of radium. Experimental evidence of the existence of this difference was obtained by the writer in a study conducted in collaboration with M. Levine.[1]

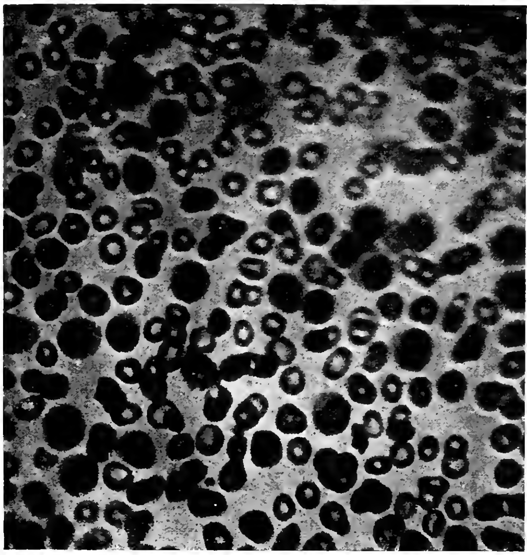


FIG. 1. MICROPHOTOGRAPH. BLOOD SMEAR OF LYMPHATIC LEUKEMIA BEFORE TREATMENT.

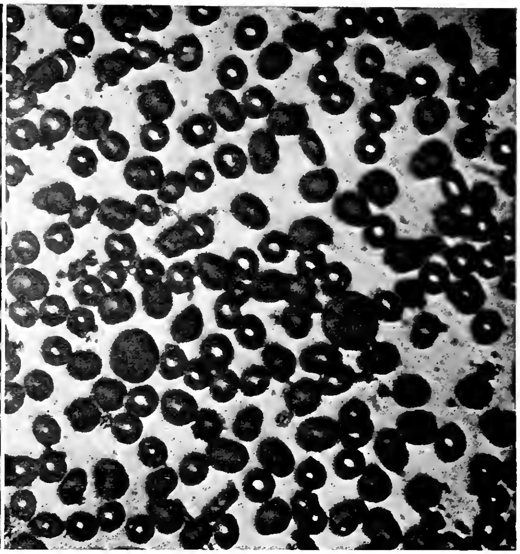


FIG. 2. MICROPHOTOGRAPH. BLOOD SMEAR OF LEUKEMIA AFTER TREATMENT.

The investigation consisted in the study of the influence of the x-rays on the lymphocytes of a turtle. This animal was selected because it has comparatively little of skeleton and bone marrow, and as a result the main type of white cells in the blood are the lymphocytes. Very large doses of unfiltered x-rays were employed, and the whole body of the turtle was subjected to the rays. Differential blood count after treatment showed that the number of lymphocytes was reduced from over 95 per cent to as little as 16 per cent.

In a second series of experiments, two turtles were superimposed and both animals rayed in the same manner as in the first series of experiments. In the upper turtle of this series, the reduction in the number of lymphocytes was as great as in the first series of experiments, while the reduction in the lower animal was much less pronounced and always remained above 50 per cent.

In a third series of experiments, a dead turtle or a layer of meat was placed over the living turtle and the whole x-rayed. In this series of experiments, the only live turtle used was at the same distance and in the same relative position to the rays as the lower turtle in the second series. Since the general absorption of x-rays and rays of radium takes place in the same degree, whether the rays pass through a living organism, inorganic matter or water, then the only live turtle in the third series of experiments did not receive a greater fraction of the whole amount of general radiation than the lower turtle in the second series; but the percentage of destroyed lymphocytes was the same as in the upper turtle of the second series. The ex-

planation of this phenomenon is as follows: The particular type of rays which is affecting the lymphocytes of the upper turtle became itself destroyed or "absorbed" in the course of its activity, and there was left a smaller quantity of this type of rays to act on the lower turtle; while in the third series the meat of the dead turtle did not contain any living lymphocytes which could "absorb" the special type of rays, and the whole amount acted on the live turtle which lay under the dead animal.

Variations in absorption of different types of rays have been shown by physical research to be true for metals, and the same is evidently also true for living tissues. Thus in contradistinction to "selective action" the term "selective absorption" means that *the same tissue may destroy or "absorb" one type of rays and not influence another.*

THE SIGNIFICANCE OF "SELECTIVE ACTION" OF THE RAYS IN THERAPY.

Both the phenomena of "selective biological action" and of "selective absorption" are of great importance for the estimation of the therapeutic value of the rays. The true valuation of the "selective absorption" cannot be obtained until a great deal more research shall have been undertaken as regards the best types of the rays, methods of filtration and correct distance to be applied in therapy. It is fairly well established, however, that the harder rays have a more selective action on the tissues than the softer rays. It is therefore self-evident that the action of radium must be different qualitatively from the x-rays and must be more beneficial for therapy.

The "selective action" of the identical type of rays on various tissues is a phenomenon of the greatest importance in therapy and places ray treatment on an equality with true specific methods of treatment, like salvarsan, mercury or quinine.

Furthermore the adjustment is even finer in ray therapy than in chemiotherapy. The chemical substances in the latter methods of therapy act on parasites which differ to a greater extent from the body cells of the host than do the tumor cells from the normal tissue cells.

The great practical value of this "selective action" of the rays consists in the fact that large quantities necessary for the treatment of malignant tumors may be employed without injuring the adjacent normal tissues. The following case indicates how well normal tissues may resist large quantities of radium sufficient to influence a malignant tumor, when the rays are correctly filtered and applied at a proper distance.

Miss L. M., forty-three years old, single. Patient had right breast removed for carcinoma July, 1918. In June, 1919, she began to experience pain in right hip, which at first was intermittent, and from December, 1919, constant. X-ray examination showed metastasis in the head of the femur. About the middle of November, 1919, patient developed esophoria of the left eye. Ophthalmoscopic examination made in December, 1919, revealed the following condition:

Disc color normal, surface flat; no elevation or depressions. Arteries and veins normal in caliber. Peri-papillary area normal. Macular area free from any pathological process. At the upper and inner quadrant of the disc vessels appear to be blurred and can be distinctly seen with the 7D lens. From this area and extending to the periphery one sees apparently a protruding mass, globular in outline, with a complete ill-defined margin. Color of the mass slightly grayish, its surface shows lighter areas, apparently no elevations or depressions on the mass. No detachment of retina apparent, also no evidence of any hemorrhage or exudation in the fundus.

Diagnosis: Metastatic tumor of the retina.

On the same day treatments were begun and the following quantities were given.

Dec. 9, 1919	83.4 millicuries applied for	5 hours.
Dec. 12, 1919	93.7 millicuries applied for	6 hours.
Jan. 7, 1920	47.4 millicuries applied for	8 hours.
Jan. 28, 1920	67. millicuries applied for	19 hours.
Feb. 7, 1920	66.7 millicuries applied for	6 hours.
Feb. 28, 1920	68. millicuries applied for	10 hours.
Mar. 13, 1920	61.1 millicuries applied for	12 hours.

At the last examination which was done in August, 1920, the area of the tumor on the retina was found to be less prominent, being only two to three D diameters elevation and passing more diffusely into the retinal structure. Apparently in the eight months since the first examination the tumor, if anything, diminished in size, and what is of greater importance, all the other tissues of the eye remained normal. In this case quantities of radium were applied to the eye sufficient to influence a large carcinoma mass, and neither the skin of the eyelid, the conjunctiva nor any of the tissues of the eyeball were impaired in any way.

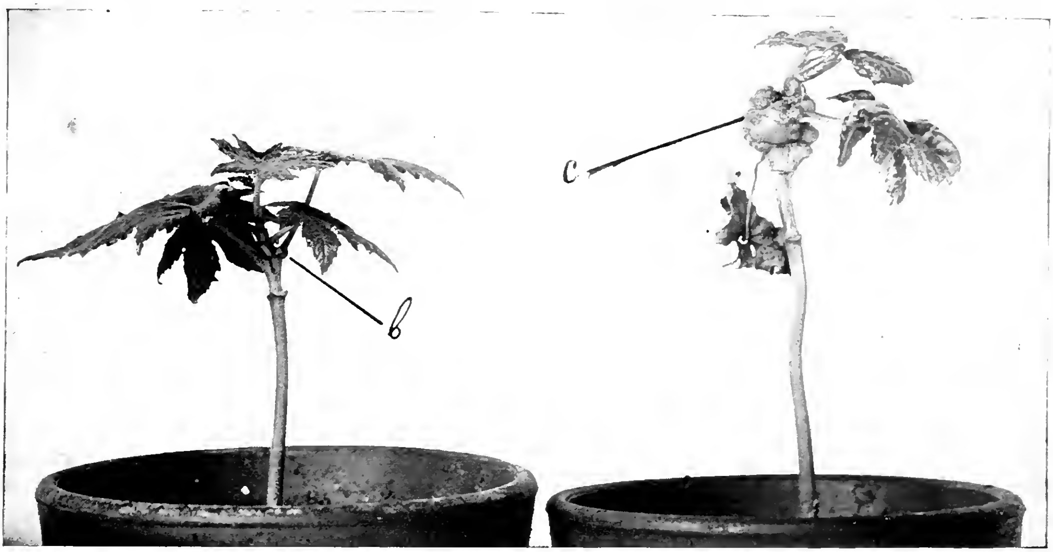


Fig. 3. To the Left an Inoculated and X-Rayed Plant, showing at b a minute swelling at the point of inoculation. To the Right an Inoculated Control Plant showing at c a fully developed crown gall. The plants themselves show no abnormality.

THE MECHANISM OF THE ACTION OF RADIUM ON CANCER

The fact that radium may destroy a malignant tumor without injuring the adjacent normal tissues is a true indication that radium does not act as a caustic but has a specific "selective action" on the tumor. What is the actual mechanism of this action? The microscopic analysis of cancer tissue submitted to radiation most generally shows marked degenerative changes in the tumor cells consisting in vacuolation of the protoplasm, pycnosis of nuclei, karyolysis, and ultimately complete necrosis of the cell. The cellular changes are accompanied by a round-cell infiltration, which is subsequently changed into dense sclerotic connective tissue, poor in blood vessels. This new connective tissue formation ultimately dominates the picture to such an extent that some observers maintain it is the only direct effect of radiation, while the destruction of the tumor cells is secondary and due to lack of nutrition.

In order to ascertain whether the rays have a direct effect on the tumor cells, the writer has undertaken in association with M. Levine,[2] a study on the influence of x-rays on the crown gall. This disease is a new growth which develops spontaneously or may be induced artificially in various plants. It presents an ideal subject for the study of the direct influence of the rays on the tumor cells, since plants do not possess any lymphoid tissue. As a result, no connective tissue forms, and the behavior of the tumor cells can be studied unobstructed. The results of this investigation show that the rays arrest the development of the tumor. While in all

the untreated control plants, there developed a large crown gall, the majority of the x-rayed plants did not develop any growth, and only a slight swelling appeared at the place of inoculation. (Figure 3 shows a

FIG. 4. AN INOCULATED AND X-RAYED PLANT, shows at *b* a stunted crown gall.

treated plant and a control.) In a few plants there developed a small stunted growth. (Fig. 4.)

The microscopical study of the radiated plants revealed a very instructive condition. Not only the stunted growths but even the minute swellings which on inspection were thought by the writer to be scars caused by the mechanical injury of the needle prick, showed the presence of morphologically unchanged crown gall cells. Figure 5 shows a fully developed crown gall, and Figure 6 shows a small group of crown gall cells in a minute swelling of a petiole (the stem of a leaf). This investigation as well as the clinical and pathological studies of the writer indicate that the first effect of the rays is exerted directly on the tumor cells. This effect consists in the inhibition of the proliferating power, in the *sterilization,* as it were, of the cancer cells. The degeneration and destruction of the cancer cells and the formation of the sclerotic connective tissue take place subsequently through the action of the rays; moreover this cell degeneration and cell death may not be due directly to the action of the rays, but takes place in the natural course of the life cycle of the cancer cell. This cycle consists of *youth,* or period of development; *maturity,* or period of function; and *senility,* or period of degeneration, which gradually leads to death. In parenchymatous organs, like the liver and kidney, the first period is usually completed during embryonic life or at very early age; the second period continues through the whole life of the organism, and the third period is attained at the old age of the organism or near its death.

The life of an individual cancer cell, on the other hand, is very short; it changes rapidly from an embryonic into an adult and then immediately into an aged, degenerated cell, and this process takes place continually, irrespective of any extrinsic aid. But in a malignant tumor the majority of the cancer cells are quickly rejuvenated before they reach senility through the fact that each cancer cell divides into two young daughter cells. When the rays arrest this proliferation, then the cancer cells, without any further

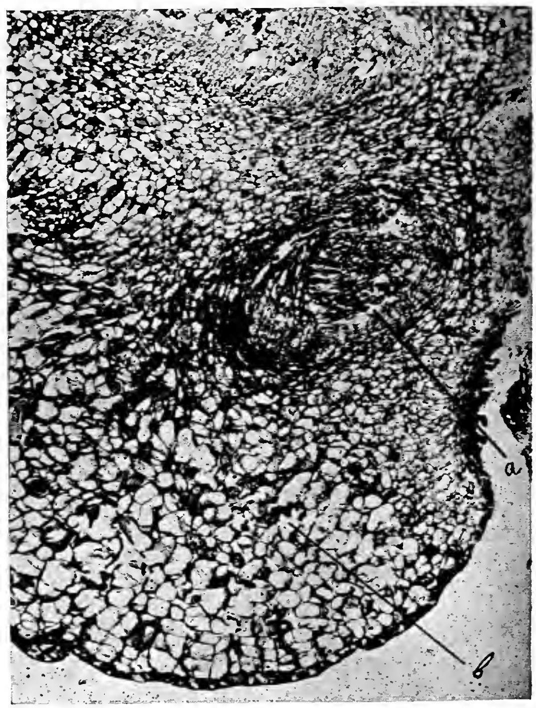


FIG. 5. MICROPHOTOGRAPH. CROWN GALL. *a* shows tumor cells, *b* normal stem cells.

outside aid, mature and degenerate. It is interesting to note in this connection that the life of the epithelium of the skin or testicle is nearly as short as one of the malignant tumors, and the rays act on these organs as specifically as they do on malignant tumors. Thus the inhibition of the proliferating power of the cancer cell and its ultimate degeneration and death constitute the primary and main action of the rays on a malignant tumor.

The round cell infiltration, which surrounds the groups of radiated cancer cells and which is subsequently changed into dense sclerotic connective tissue, is of secondary occurrence, though for practical purposes it is of greater importance than the destruction of the cancer cells themselves. The importance of the connective tissue consists in the following. After the most perfect results of radiation, there may remain a certain number of viable though stunted cancer cells; the dense connective tissue wall surrounds these cells and keeps them in check.

THE RÔLE OF THE NEWLY FORMED CONNECTIVE TISSUE.

The formation of the connective tissue around the rayed cancer cells is not due to the direct influence of the radiations, and raying of other conditions like thyroid gland, cheloid, etc., is not followed either by cell infiltration or by connective tissue formation.

The experimental investigations of the writer [3] indicate that this connective tissue formation may represent an attempt by the organism to protect itself against the further growth of the cancer by walling it off from the normal tissues by a connective tissue barrier.

In a series of experiments on inoculable cancers of the white rat, the writer has shown that when particles of the tumors were inoculated into internal organs (liver, kidney, brain, testicle and so on) of susceptible animals, the tumor grew diffusely, invaded the normal tissues of the organ, and there was no connective tissue formed around the graft. Furthermore the adjacent normal tissues became diseased [4] (fatty degeneration) under the influence of the growing tumor before they were invaded by the latter.

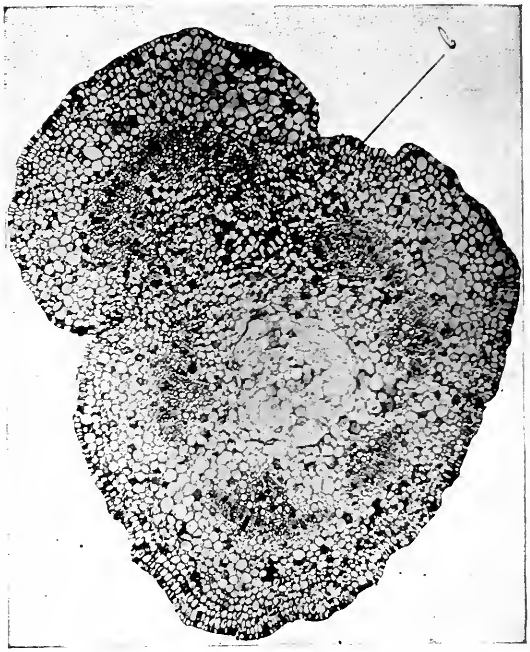


FIG. 6. MICROPHOTOGRAPH. CROSS SECTION OF A PETIOLE. Shows at *b* a small group of tumor cells.

In another series, the animals were made by a preliminary treatment resistant to the growth of the tumor, and then particles of the tumor were inoculated into internal organs. In these animals the grafted cancer tissue did not grow but was surrounded by newly formed connective tissue. Thus it appears that when the cancer cells are malignant and proliferate they also interfere with the formation of the connective tissue wall. When the animal is resistant it inhibits the proliferation of the cancer cells and creates at the same time a connective tissue barrier. A similar mechanism most likely takes place in the course of the raying of cancer tissue. The rays inhibit the proliferating power of the cancer cells and destroy their malignancy. The organism is then enabled to form

a protective connective tissue barrier around the tumor.

That this conception is plausible may be gathered from the fact that a number of

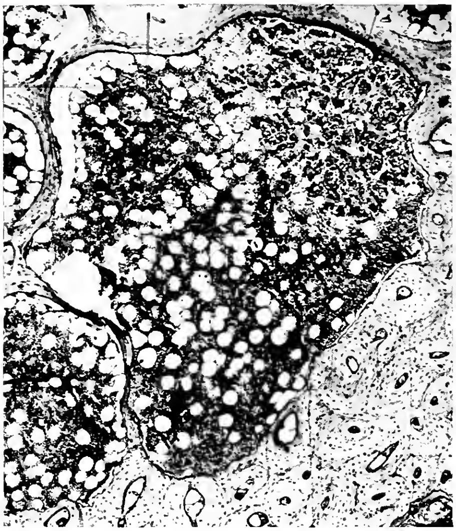


FIG. 7. MICROPHOTOGRAPH. MINUTE NODULE OF CARCINOMA IN THE BONE MARROW. *a* shows carcinoma; *b* normal marrow.

pathologists (Borst,[5] Schmidt,[6] Orth[7]) describe the same phenomenon as occurring spontaneously in the human. A connective tissue stroma surrounds a group of cancer cells, gradually increases in size, compresses

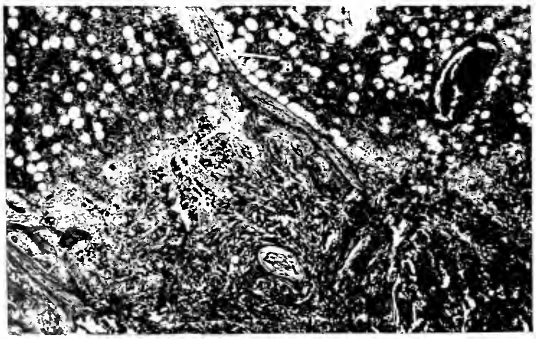


FIG. 8. MICROPHOTOGRAPH. SHOWS A GREAT DEAL OF NEW BONE FORMATION IN THE VICINITY OF AN OLD BRIDGE OF COMPACT BONE TISSUE. *b* shows old bone; *a* new bone.

the cancer cells and produces a local cure of the growth.

In other words radium and the x-rays perform with greater precision and by far greater frequency what the organism itself attempts to do haltingly and in rare instances.

FIG. 9. MICROPHOTOGRAPH. TWO BONE LACUNAE FILLED WITH CARCINOMA CELLS. Low magnification. A shows bone; B carcinoma.

ACTION OF RADIUM ON MALIGNANT TUMORS OF THE SKELETON.

The mechanism of the action of the rays on malignant tumors, the sequence of events as well as the fact that results obtained through this action resemble the phenomena which occur spontaneously in the organism, can be demonstrated most clearly in the study of the influence which radium exerts on carcinoma and sarcoma of the skeleton.

In a pathological study of skeletal metastases of carcinoma, the writer[8] has shown that the metastasis usually begins its development within the marrow, and when the nodule of carcinoma is small, the surrounding bone-marrow appears quite normal (Fig. 7). As the tumor nodule increases in size, it

approaches and invades the compact osseous tissue or the compact osseous partitions of the cancellated bone. Then there begin to appear characteristic changes in the bone tis-

Fig. 10. Microphotograph. Microscopic Section of a Skeletal Metastasis Stained with Van Gieson. Shows Collagen fibrils emerging from the old bone and uniting with other fibrils.

sue. These changes are of two types, *osteoplastic,* in which extensive new bone formation takes place around the metastatic tumor, and *osteoporotic,* in which the changes consist in destruction of the compact bone. The studies of the writer have shown that both conditions are usually present. Figure 8 shows an extensive new bone formation, and Figure 9 shows only destruction of the old bone, and both specimens were obtained from different regions of the same metastatic tumor. The destruction of the old bone is caused mainly by the cancer cells themselves acting as osteoclasts, as is clearly seen in Figure 9. Figure 10 shows collagen fibrils formed from the old bone. These fibrils gradually unite in thick bundles and subsequently form new bone.

Most frequently the metastatic nodule increases in size, suppresses the power of the organism to create new bone and progressively destroys the old bone. The spontaneous healing power of the organism is thus quite imperfect and comes into play very rarely indeed. In a previous communication the writer [9] has shown that radium therapy may enhance the healing power of the organism, destroy at least a major part of the malignant tumor, and surround it with newly formed bone. Further progress of this study may be reported here. The three cases reported in the previous publication are well to-day, six, five and a half, and five years respectively since the beginning of the treatment. Figure 11 shows the roentgenogram of one of the three cases five years since the beginning of the treatment. The metastasis in the spine—second and third lumbar vertebra—became manifest six months after a radical amputation of the breast. In November, 1915, the patient entered Montefiore Hospital, suffering from paraplegia dolorosa. At present the patient is clinically well.

Fig. 11. Roentgenogram. Metastasis of Carcinoma in the Second and Third Lumbar Vertebra Five Years after Treatment.

The roentgenogram taken in August, 1920, shows a good deal of new bone formation in comparison with the findings five years ago.

Figures 12 and 13 present two roentgenograms of the right clavicle of a boy seventeen years old who suffered from multiple sarcomata of the skeleton with metastasis in the lungs to which the patient succumbed. Radium was applied experimentally to the tumor of the clavicle. Figure 13 shows clearly that the tumor of the soft tissue disappeared, and a great deal of new bone was formed.

Fig. 12. Roentgenogram. Sarcoma of Clavicle.

Figures 14 and 15 present roentgenograms of the spine of a woman twenty-seven years of age whose right breast was removed for carcinoma in November, 1918. A year later there developed a paraplegia dolorosa, the patient entered the Lenox Hill Hospital, roentgen examination showed destruction of bone of the fifth lumbar vertebra. On January 21, 1920, the first radium application to the affected bone was given. In August, 1920, seven months later, a roentgenogram (Fig. 15) was taken and it shows a good deal of new bone formation. At the same time the clinical condition of the patient is greatly improved.

THE ADVANTAGES OF THE USE OF BURIED EMANATION TUBES.

The data furnished in this paper indicate that radium exerts a truly specific selective action on cancer tissue. Biologically, then, radium therapy in cancer has a thoroughly scientific foundation and presents the nearest approach to a specific therapeutic measure against the disease. In practice, however, the action of radium has its limitations, and the results obtained thus far vary in accordance with the size and location of the tumor. The effectiveness of the rays diminishes in inverse ratio to the increase of the distance and the size of the tumor. A preliminary surgical removal of the main mass of the tumor, even when radical surgery is impossible, diminishes the difficulties in connection with the size of the tumor. The placing of the radium in near approximation to or within the tumor does away with the disadvantages which are presented by a greater distance between the source of radiation and the tumor.

Fig. 13. Roentgenogram. Sarcoma of Clavicle after Application of Radium. Shows new bone formation.

A new method was recently developed by Duane of Boston which obviates to a great extent the difficulties created both by the size and location of the tumor. It consists in the use of buried radium emanation tubes.

Each minute glass tube contains not more than about 3 millicuries. A sufficient number of the tubes is buried in the tumor to cover its whole mass and is left there permanently. The emanation decays after a time and the tubes become inert.

While this method is simpler and frequently more efficient than the external application of radium, one must not lose sight of the fact that the action of the buried emanation is not as strictly selective as the external application of well-filtered rays. The emanation in the minute tubes is filtered only by the glass walls of the latter. Therefore the soft beta rays also act on the tumor and may produce small foci of necrosis around the buried tubes. Care must be taken, therefore, not to place the tubes too near the surface of the tumor nor too near large blood vessels or nerves. Neither must the emanation tubes be placed too near each other. But with correct technique this method will in the near future supersede the external application of radium in combination with incomplete surgery and become the method of choice in many conditions. The method of buried emanations should always be accompanied, however, by external application in the areas of the regional lymph glands and the areas directly adjoining the tumor.

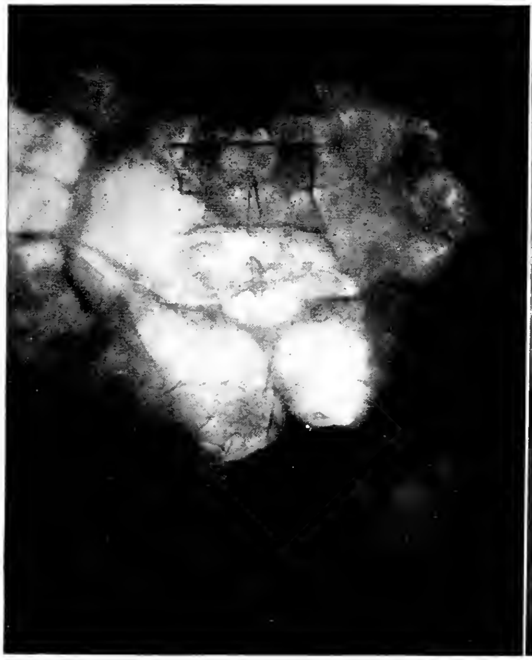


Fig. 14. Roentgenogram. Metastasis of Carcinoma of the Fifth Lumbar Vertebra.

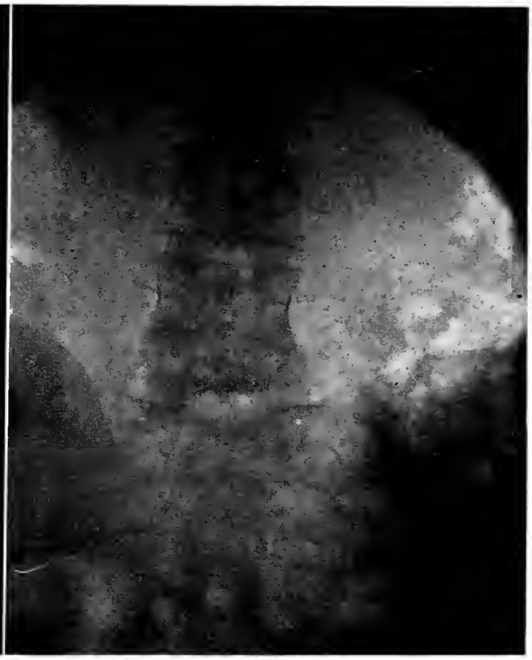


Fig. 15. Roentgenogram. Metastasis of Carcinoma of the Fifth Lumbar Vertebra after Application of Radium. Shows new bone formation.

THE CORRECT FUNCTION OF RADIUM AND THE x-RAYS IN CANCER THERAPY.

There has developed in some quarters recently a tendency to apply to a cancer patient one intense dose of radium or x-rays which is not to be followed by another application for a long period of time, if at all. In this manner an attempt is made at a radical cure of the disease.

In the opinion of the writer, this method is erroneous and must be followed by many ultimate failures for this reason: As stated above, the first action of the rays on the cancer cell consists in the inhibition of the *pro-*

liferating power of the nucleus. As a result the cancer cell does not divide into two young cells but enters the state of maturity. Such a *matured* cancer cell or a *stunned* cell, as stated above, may remain alive and it is then probably as resistant to the rays as the adjoining normal tissue cells and may not be destroyed by the rays. None the less it is potentially a cancer cell, and it may recover sooner or later its proliferating power and create a new tumor mass if it is not radiated repeatedly. Such a cancer cell in its matured state may appear on superficial analysis as a radio-resistant spore in bacteriology. The whole phenomenon, however, of the temporary resistance of an individual cancer cell to the radiations as explained above is an entirely different condition and must be treated accordingly.

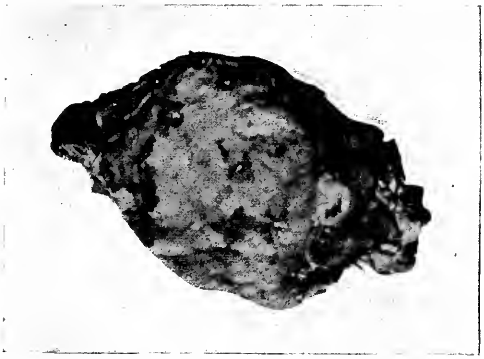


Fig. 16. Photograph of a Recurrent Nodule of Carcinoma Treated by Radium. Darker area on the surface presents new carcinoma tissue.

No matter how intensive the radiation, it is just as incapable of destroying in every patient all the cancer cells of the treated region as radical surgery is of curing 100 per cent of the operated cases. Therefore the correct technique consists in repeated applications of a correct dose at stated intervals. The insertion of buried emanation tubes should usually be done only once in the same region; but it must be followed by repeated external applications in the surrounding areas.

The following case illustrates clearly the necessity of repeated applications. The patient developed, subsequent to an amputation of the right breast for carcinoma, a nodule of recurrence in the infraclavicular region. Several applications of radium were given. The nodule at first diminished somewhat in size and then remained stationary. The patient discontinued treatment, and when she was seen several weeks later the nodule appared to have increased in size. The nodule was then excised and examined microscopically. The findings were very instructive. Nearest to the skin there was found a thin layer of active carcinoma tissue, while the rest of the nodule throughout its depth consisted of dense connective tissue and did not contain any cancer cells. The only plausible explanation of the appearance of the specimenis as follows: Radium destroyed all the cancer tissue and left behind only a few scattered viable cancer cells in the vicinity. These cells formed a new tumor on thetopofthe old nodule when the treatment was discontinued. Were the whole layer of active cancer tissue a part of the original nodule then it would have been the first to be influenced by radium, since the latter produced a perfect effect on the whole depth of the nodule This case thus proves conclusively that scattered viable cells may remain uninjured in the path of the rays, even at the surface of the

Fig. 17. Microphotograph. Low power. The darkest area on the surface shows new carcinoma tissue.

tumor where the action of the rays was most intense. Hence the necessity of repeated radiations is apparent. Figures 16 and 17 show a gross photograph and a low power microphotograph of the nodule.

Besides the recurrences at the periphery of or at a short distance from the region of the primary tumor the most important cause for the failure of all methods of cancer therapy is the formation of metastases in distant regions of the organism. In the early stages of the disease, these metastatic nodules may be too small to be detected, but they increase in size and virulence while the primary tumor is being treated. The only method at our command to lessen the frequency of these two types of recurrences is to ray prophylactically the regions in which the formation of recurrent or metastatic tumors is probable, and this is in the estimation of the writer the true function of *x*-ray therapy in cancer. For the destruction of a discrete circumscribed cancer nodule of a fair size, the action of radium applied by the aid of modern technique and in the large quantities which most of the operators control to-day, is by far superior to the *x*-rays. On the other hand the *x*-rays should be used when a great deal of ground has to be covered, but where all the nodules are minute or even microscopical. This is the aim of the so-called prophylactic *x*-ray treatment of the chest or of parts of the skeleton. All these areas frequently contain disseminated microscopical groups of cancer cells, though there is no clinical evidence of discrete metastases.

CONCLUSION

To a casual observer it may appear that the practical therapeutic results obtained by radium in cancer should not warrant the enthusiasm of the radiumtherapeutist. But a closer student in the domain of radiumtherapy cannot fail to appreciate the fact that radium is the most powerful agent in the whole therapeutic armamentarium of medicine, and that the selective action of the element, when the quantity and quality are correctly adjusted, presents a most remarkable phenomenon. Moreover not all of the failures by far must be ascribed to the inefficiency of the agent. The percentage of cases suitable for radiumtherapy is as small as the number of cases suitable for radical surgery.

Even if radiumtherapy should not have accomplished anything else, it is of great value because it is gradually dissipating the feeling both within the profession and the laity, that a diagnosis of cancer means a death warrant. The association between radium and cancer is also becoming more generally realized. As a result the radiumtherapeutist is being called upon with increased frequency to decide on matters which are purely in the domain of cancer research. It is imperative therefore that every radium worker should become a student of the whole domain of cancer research—biology, pathology, clinical diagnosis, surgical or combined therapy. Each radium establishment which controls large quantities of element, should become a center for cancer research. Both greater success in the results of radiumtherapy in cancer and progress in the knowledge of the whole cancer problem will follow this course of action.

BIBLIOGRAPHY

1. I. Levin. *Ann. Surg.*, November, 1919, 561.
2. I. Levin and M. Levine. *Proc. Soc. Exper. Biol. & Med.*, 1917, xv, 24.
3. I. Levin. *J. Exper. M.*, 1911, xiv, 139.
4. I. Levin. *J. Exper. M.*, 1912, xvi, 149.
5. M. Borst. Die Lehre von den Geschwulsten. *Weisbaden*, 1902, ii, 622.
6. M. B. Schmidt. Verbreitungswege der Karcinoma. *Jena*, 1903.
7. Orth. *Ztschr. f. Krebsforsch.* 1904, i, 399.
8. I. Levin. *Proc. N. York Path. Soc.*, 1915, xv, 81.
9. I. Levin. *Ann. Surg.*, March, 1917, 327.

A STEREOSCOPIC TUBE STAND PARTICULARLY ADAPTED FOR THE EXAMINATION OF THE SKULL

BY PAUL C. HODGES, M.D.

Department of Roentgenology, Union Medical College,

PEKING, CHINA.

THE apparatus here illustrated was designed with the idea of simplifying the examination of the mastoids, sinuses and jaws—including the lower molar teeth—by the stereoscopic method. Its chief difference from existing apparatus lies in the fact that when the angle of the central ray is once chosen it remains fixed during the exposure of both plates, except for a shift of five degrees each way from the center. This shift does not affect the centering of the ray. A practical modification of the well-known weighted bandage for immobilizing the head during the exposure is also described.

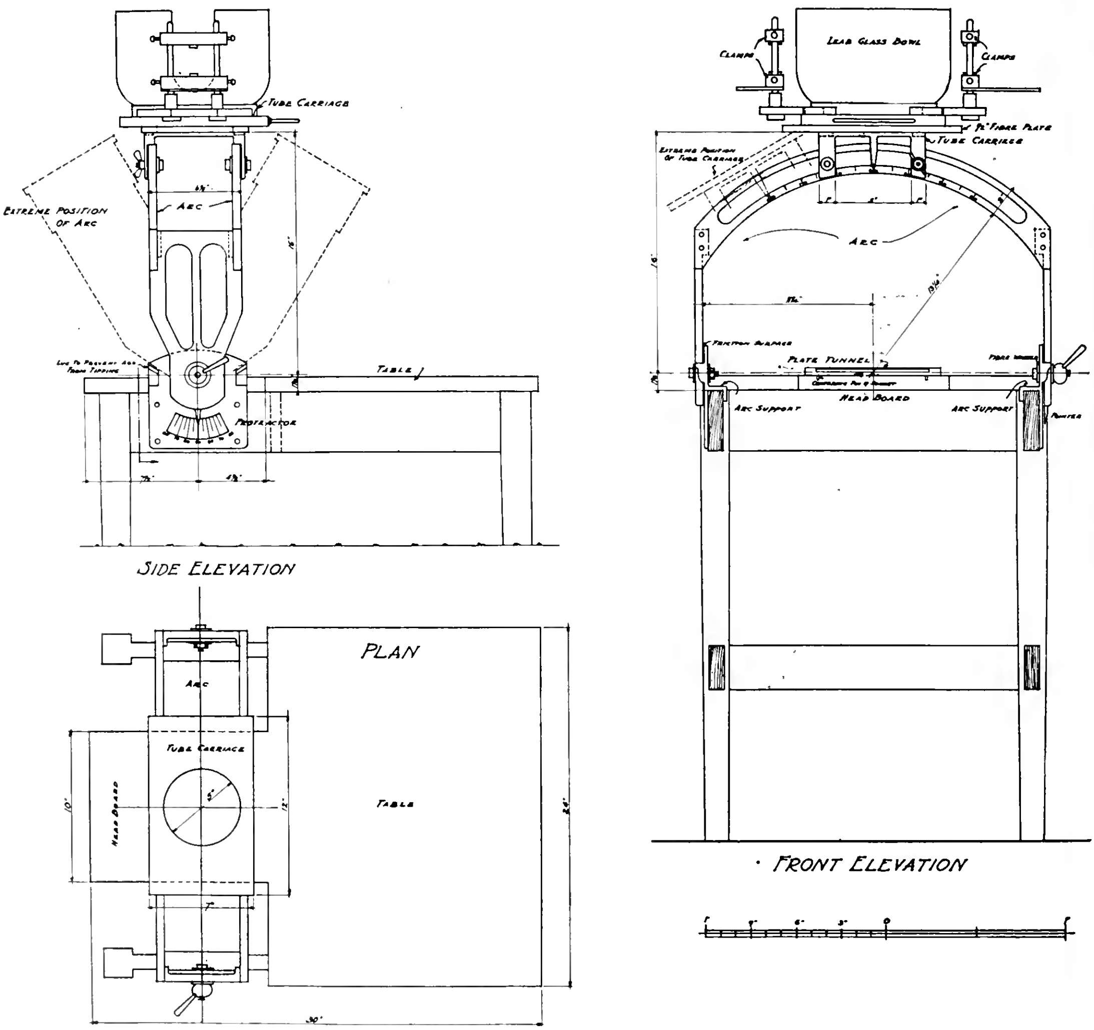


FIG. 1. DIAGRAM OF TUBE STAND SHOWING TOP, FRONT AND SIDE ELEVATIONS.

During six months of constant use the machine has performed satisfactorily in the

writer's laboratory, apparently supplying a solution to the problem of consistent stereoscopic skull technique in busy laboratories, where the exposures must be made by technical assistants.

Fig. 2. Showing the Extremes of Motion of the Arc and of the Tube Carriage. Also the Head Strap and the Adapter for 5 x 7 Films.

Fig. 3. Showing the Stereoscopic Tube Stand Assembled.

The base consists of a small wooden table made the same height as the exposing table. The table top is cut out in the manner illustrated (Fig. 1), so that a central tongue remains as a support for the aluminum plate tunnel, with notches on either side for the passage of the immobilizing bandage. Bolted to either side rail are aluminum supports, and pivoted from these supports rises an aluminum arc which serves as the bed for a carriage mounting the tube clamps, lead glass bowl and tubular diaphragm. By moving the arc forward and backward and moving the tube carriage to the right or left the focal spot of the tube can be made to occupy any desired point on the upper surface of an imaginary sphere, the center of which lies at the center of the x-ray plate. It is impossible, therefore, to make the central ray fall anywhere except on the center of the plate.

A protractor is fastened to the right hand arc support, and a pointer on the arc indicates the number of degrees to which the arc

Fig. 4. Setting the Stand for the First Exposure of a Pair of Mastoid Plates.

is tilted away from the transverse plans in either direction. The arc itself is also marked in degrees and the tube carriage carries a pointer to show the degrees of displacement to the right or left of the longitudinal plane. With both pointers at zero the central ray is perpendicular to the plate, and when its direction is altered in either or both planes, the foot point still lies at the center of the plate. To determine, therefore, the point on the skull from which the rays are going to emerge, one has merely to select that point in contact with the cross mark in the center of the aluminum plate tunnel. Or conversely, when it is desired to cause the central ray to pass through the skull in a particular direction in relation to—say—the saggital plane, and emerge at a given point, say the external auditory meatus, one has merely to place the head with the saggital plane parallel to the plate, and with the external auditory meatus directly over the center of the plate, and then adjust the tube carriage to the desired angles. For stereoscopic effects the tube is now shifted five degrees each way from the selected angle on the arc.

Fig. 5. The Position for Frontal Sinuses.

Fig. 6. Position for Lower Left Molars with Tube Angled 70 Degrees from Behind and Displaced 10 Degrees to the Left.

The head strap was devised to overcome the nuisance of improvising a bandage for each new case. It consists of two-ply white cotton cloth 4½ feet long and 4½ inches wide at the broad end. The perforations at either end are reinforced by tape or metal so that they will not be torn by the hooks that fasten them to the sandbags. The slit for receiving the small end of the strap is overcast to strengthen it. Such straps are provided in quantity so that they can be laundered fresh for each patient.

A sheet metal tray is provided to adapt 5 by 7 film holders to the 8 by 10 tunnel, this size of film being quite satisfactory for examination of the mastoid region and the lower molar teeth. 8 by 10 films are used for examination of the sinuses.

The photographs illustrate the technique for mastoids, sinuses and teeth.

THE AMERICAN JOURNAL OF ROENTGENOLOGY

PUBLISHED BY PAUL B. HOEBER, NEW YORK CITY

Issued Monthly. Subscription, $6.00 per year. Advertising rates submitted on application. Editorial office, 480 Park Av., New York. Office of publication, 67-69 East 59th St., New York.

SECOND ANNUAL MEETING. EASTERN SECTION

The Second Annual Meeting of the Eastern Section of The American Roentgen Ray Society will be held in Atlantic City at Haddon Hall-Chalfonte, on Friday evening and Saturday, January 28, 29, 1921. Make hotel reservations early.

Communications regarding the program should be addressed to Dr. David R. Bowen, 82 West LaCrosse Ave., Lansdowne, Pa.

In all other matters concerning this meeting, address Dr. Joseph M. Steiner, 103 Park Ave., New York City.

THE LEONARD PRIZE FOR RESEARCH

THE AMERICAN ROENTGEN RAY SOCIETY will award $1000.00 to the author of the best piece of original research in the field of the *x*-ray, radium or radio-activity. The competition is open to anyone living in the United States or its possessions, in Canada, Mexico, Central or South America, Cuba or other islands of the Western Hemisphere. The research matter must be submitted in literary form in the English language not later than July 1st, 1921, and must never have been published. Each paper must be signed by motto and accompanied by a sealed envelope containing motto and name, so that the identity of the author may be disclosed after the award has been made. In case a demonstration of an invention or method is necessary, the identity of the author may have to be known before the award is decided.

The field of research includes discovery, invention, improvement of method, or investigations to prove or disprove any theory or problem, whether old or new, which has a direct bearing upon the use of *x*-rays, radium or other radio-active substances.

This competition is not open to any research involving a patent or copyright, and the submission of any research work for this prize carries with it the understanding that the subject matter will remain open to free use for the general good.

The committee reserves the right to withhold the award if in its judgment no piece of research offered possesses sufficient merit. It also reserves the right to divide the award if two papers are judged to be of equal merit. A certificate of honorable mention will be given to the author of meritorious research which has been submitted but which has not received the prize.

Papers, records or material are received in this competition only with the understanding and agreement that any work receiving award or honorable mention may be published in The American Journal of Roentgenology at the discretion of the research committee. All expenses of publication will be borne by the Journal. Papers not published will be returned to the authors.

The piece of original research receiving award must be presented before The American Roentgen Ray Society at its next Annual Meeting, September, 1921.

This prize is offered in an altruistic spirit for the promotion of useful research, with the approval of the National Research Council. It commemorates the name of a martyred member of The American Roentgen Ray Society, Dr. Charles Lester Leonard, who paid the supreme penalty for his pioneer research in the field of the *x*-ray.

Communications may be opened with any member of the following committee:

A. W. Crane, *Chairman*
420 South Rose St., Kalamazoo, Mich.
P. M. Hickey, M.D.
32 Adams Ave. W., Detroit, Mich.
Henry K. Pancoast, M.D.
University Hospital, Philadelphia, Pa.

DR. MILLS'S ADDRESS

Dr. Mills's memorable address at the Minneapolis meeting presented ideals of roentgenologic practice that are not beyond our reach. To review the history of the case, the physical examination, the laboratory findings, and to correlate with them the roentgenological interpretations, is to exercise the true art of diagnosis. The roentgenologist then qualifies as a consultant on an equal footing with the internist or the surgeon. It is to this end that he should have a medical degree and a working experience in hospital or general practice. He should feel the pride and support of professional traditions and cultivate the same sensitive ethical sense as the men with whom he would consult. His status is then fixed beyond the competition of technicians and irregulars.

Under the spell of Dr. Mills's words the practice of roentgenology takes on greatly increased interest. The problems widen to include nearly the entire domain of medical and surgical diagnosis. It again becomes necessary to read medical journals, to study the latest volumes on practice, and to attend medical societies. The narrowing effect of a specialty is lost because the specialty of roentgenology thus conceived leads into a professional life of unusual breadth and perspective.

No other great province of medical science is so new and so rich in promise as roentgenology. Its fruits are already found in nearly every other department of practice. It offers unmeasured tracts of research to the investigator. It touches chemistry, physics, the activities of the electron, and the constitution of matter as intimately as it does the diagnosis and treatment of disease.

To have clinical experience is more than desirable, but to be a pathologist is not less than a necessity to the best type of roentgenologist. *X*-ray interpretation is a statement of screen and plate findings in terms of pathology. The *x*-ray furnishes to the diagnostician an exquisite analysis of densities, but nothing else. The evidence is presented to the sense of vision only. From such data we have to define the extent of disease and deduce its nature as far as possible. Bone lesions offer the clearest examples of pathological interpretations. But in the wider field of internal disease we must beware lest we go beyond our premises and draw conclusions warranted only by a digest of the entire case.

The import of Dr. Mills's contentions applies with undiminished force to the practice of *x*-ray therapeutics. The skilled physician is needed to prescribe this unfelt and unseen agent, no less than to prescribe tablets and tinctures. The expansion of *x*-ray treatment will in the future be seen to mark an era in

medicine. It comes at a time when the decay of faith in drugs has left the therapeutic field to the dominant sway of the surgeon. There is therefore a province to be reconquered by the most powerful and least tangible agent that has ever been used to mitigate the sufferings from disease.

The x-rays and radium are indissolubly associated both in therapeutics and in nature. They bear something of the same relation that the electro-magnet bears to magnetic ore. One is the result of the electric current, the other a product of earth. But their essential activity is identical. Everything about radio-activity stimulates speculation. The action of radiations on the living cell forms or will form a basal chapter in therapeutics. Some sort of radiant energy seems to be the basis of the activity of most medicinal substances. The presence of end-products of radium, widely scattered through the earth's crust, suggests that radium was once in astonishing abundance on this planet. We are led to wonder if what Bovee has called the imponderable environment of radiations was not the most powerful influence in the evolution of primordial protoplasm. What then would be the rationale of the restoration of the evolutionary environment of living matter?

Speculation of a highly tenuous nature thus goes hand in hand with the intensely practical matter of curing disease. Research in pure science, seemingly at an infinite distance from the practical affairs of life, have time and again proven in the end to be of inestimable utility. The history of scientific research is a fairy tale of the transmutation of speculations and experiments into power and production. Faraday's absorption in twirling a metal disc between the ends of a magnet was doubtless unintelligible to the hard-headed business man of his day; yet the business man of our day runs factories and locomotives and illuminates cities as the consequence of this first experimental plaything. The x-ray was conceived in the theories of Brookes concerning the fourth state of matter. His experiments with the transmission of electricity through vacuum tubes was the purest example of pure science undefiled by any apparent utilitarian possibility. Yet few discoveries in the history of civilization can equal the practical consequences of these experiments. Research therefore should be encouraged and sustained by our society as the best expression of our scientific faith and our best contribution to future generations.

We need other addresses from Dr. Mills to uphold our ideals and make us think. Our opportunities are always greater than our achievements. But let us hold high the torch. Whether our roentgenologist is a diagnostician or a therapist we would have him be an experienced clinician, an able pathologist and withal a man of the broadest scientific culture.

A. W. CRANE.

AN EPIGRAM

"I AM A PHYSICIAN PRACTICING SURGERY."
SIR BERKELEY MOYNIHAN.
(Lecture at the Academy of Medicine, N. Y., October 21, 1920.)

A great phrase uttered by a great surgeon! How well it would be if every roentgenologist reminded himself daily that:

"I AM A PHYSICIAN PRACTICING ROENTGENOLOGY."

AMERICAN ASSOCIATION OF MILITARY ROENTGENOLOGISTS

At the Annual Meeting of THE AMERICAN ROENTGEN RAY SOCIETY at Minneapolis an association of roentgenologists, called the American Association of Military Roentgenologists, was organized with the following officers elected:

President
Col. A. C. Christie
Vice-President
Henry K. Pancoast, M.D.
Secretary
F. F. Borzell, M.D.

Information concerning the organization

will gladly be given upon application to the Secretary. Those eligible to membership are officers of the Medical Corps and Sanitary Corps who were actively engaged in the Roentgen Ray Service during the Great War, either at home or abroad.

F. F. Borzell, *Secretary.*
1119 Harrison St., Philadelphia.

NOTICE

To the Members of the
American Roentgen Ray Society,

The Committee on Revision of the Constitution recently appointed will hold its first meeting at the Mid-Winter Session of the Eastern Section at Atlantic City. It is very desirable that those members of the Society who desire to present amendments to the Constitution should send them to the Chairman of the Committee before the first Committee meeting. This would allow the Committee sufficient time to consider definitely and coordinate the various suggestions.

At the Annual Meeting, this Committee was authorized to publish its recommendations in the June number of the Journal.

This will allow sufficient time to permit all the members to consider the proposed amendments very carefully.

(Signed) A. L. Gray, *Chairman.*
E. C. Samuels,
P. M. Hickey.

TRANSLATIONS & ABSTRACTS

PHEMISTER, D. B. The Recognition of Dead Bone Based on Pathological and X-Ray Studies. *(Annals of Surgery,* Oct., 1920. Vol. lxxii, No. 4, pp. 466–485. 17 Figs.).

When bone dies rapidly and in appreciable quantity from infection in osteomyelitis, compound fractures, tuberculosis and rarely in lues, it is at first indistinguishable either by gross or roentgenologic appearance from the adjacent living portions. Only after the occurrence of further changes in the living and the dead bone can its extent be determined. A detailed knowledge of these changes is essential for diagnosis and for planning suitable and properly timed operations.

The points by which we distinguish between dead and living bone are density, demarcation, and contour. These are best determined by means of the x-rays and can be expressed as follows: The density of dead bone is greater than that of an equal volume of surrounding living bone. It retains its original compact texture. Living old bone has its density evenly reduced by atrophy and is occasionally streaked from dilated longitudinal cannular markings. Newly formed bone is of low density and spongy in texture. However, there are numerous variations from these general statements. Dead bone when extensively eroded has its shadow density reduced, which may be equal to or below that of the living bone, but is distinguishable from the latter by its blotchy uneven character. Secondary sequestra usually show no variation in density from the adjacent living bone. The line of demarcation between dead and living portions is usually sufficiently wide and clean cut to be of great value in diagnosis, but any oblique or tortuous portions may be indistinguishable. Notches or unevenly streaked lines may indicate incomplete separation of the dead piece.

The outline of the sequestrum is of great diagnostic value. Its surface is smooth, sharp, straight where unattacked, but irregular and jagged where erosion has occurred. Sharp spicules, especially about the ends, are frequently to be made out. Preservation of the smooth curved cortical rim in sequestra bordering on an articular surface and of clean-cut fracture lines late in infected fractures are points of value. The compact texture of dead bone gives its outlines a sharpness that the less dense and frequently growing living surfaces do not possess. Evidence of irregular destruction of spongy bone at the ends of the shaft in osteomyelitis is a sign that dead portions are present though their outline cannot be determined.

There are many difficulties in distinguishing dead bone in the x-ray, the greatest of which results from overlapping of shadows of necrotic and living portions which obscures the details of each. This can be obviated by marking plates at different angles.

The presence of dead bone can nearly always be diagnosed, but frequently the exact number of pieces cannot be determined, especially when they are small. At operation in osteomyelitis and infected fractures we often find twice as many sequestra as were suspected from the x-rays.

Wounds containing small sequestra may heal and remain closed indefinitely, but eventually lighting up of the infection may occur. Ununited fractures and defects requiring bone transplantation should be scrutinized; if tiny healed-in sequestra be found, they should be removed and the transplantation postponed until the wound has sufficiently long healed.

The difference in density between dead and living bone in septic necrosis suggested the possibility of a similar occurrence in aseptic necrosis, such as takes place in uninfected bone transplants. Histological studies have shown that nearly all of the transplanted compact bone undergoes aseptic necrosis which, after reestablishment of the circulation, is gradually replaced by new bone formed from the surviving unossified osteogenetic elements of transplants in case the latter takes, or growing in from the surrounding bone where it does not take.

Experiments on dogs have shown that atrophy occurs more rapidly in the adjacent living bone than in the transplant, because time is required for the reestablishment of circulation and the beginning of absorption in it with

replacement of the dead cortex by new and less dense bone. A section of ulnar shaft two-thirds to one and one-half inches long, excised and reimplanted, is denser and casts a heavier shadow from the fourth to the tenth week than the adjacent atrophied fragment. After this time the density of the transplant gradually approaches that of the fragments.

A difference in density gradually develops between the infected and uninfected portions of a human transplant. This is illustrated by the following case: A tibial inlay graft was inserted for ununited gunshot fracture of the lower end of the humerus. Mild infection occurred with fistula formation at the seat of the fracture. Two centimeters of the lower end of the graft underwent septic necrosis and separated as a sequestrum. It casts a heavier shadow than the rest of the graft which took and has undergone considerable transformation.

Medico-Legal. Liability of Roentgenologist. (Gross v. Robinson [Mo.], 218 S. W. R. 924.) (*J. Am. M. Assn.*, Vol. lxxv, No. 16, p. 1087.)

The Kansas City (Mo.) Court of Appeals says that, according to his allegations, the plaintiff, having had one of his ribs fractured, applied to the defendant to have a roentgenogram of it made. The defendant exposed him to the roentgenographic rays twelve or fifteen times more or less within two weeks, or for approximately 375 seconds, at a target skin distance of about 10 inches, using about 30 milliamperes of current, and with a spark gap of not less than 2½ inches, causing severe and lasting injuries. The trial resulted in a verdict in the plaintiff's favor for $10,000 damages, of which $2,500 was remitted, and a judgment for $7,500 was rendered, which is here affirmed.

Complaint was made that the trial court allowed the plaintiff to introduce evidence tending to show a machine which lacked certain appliances, when such condition was not pleaded. The avowed object in such testimony was only for the purpose of proving the negligence charged; that is to say, if a machine was not equipped with a filter, it was negligence not to use it. There was no pretense that the absence of the filter was, itself, negligence. But a filter being absent, it was negligence to make a certain character of exposures for a certain time, without the protection of a filter. Such evidence was necessary for framing an intelligible hypothetic question to an expert. Furthermore, evidence tending to show that the sore made by the burn would probably become malignant was given and justified under the plaintiff's petition.

A salesman for the company that had sold the machine to the defendant was at the latter's office and, after the defendant had failed with one or more exposures, was asked to try whether he could take one, which he attempted to do, but failed. It further appeared that, after the defendant had made several failures, he telephoned, in the plaintiff's presence, to another physician, and asked him to come and take a picture. The physician came, made the attempt, but got no picture. The defendant contended that he was not liable for the acts of either of these uersons, and that as their attempts to secure a picture may have been the exposures that caused, or substantially increased, the plaintiff's injury, a case was not made against the defendant. With regard to the responsibility of the defendant for the acts of the other physician, it seems that the relation of master and servant, or of principal and agent, does not exist between two physicians where one has been sent to treat the patient of the other with the consent of the patient. In such instance the rule of respondeat superior or let the master answer, does not apply. From this legal standpoint, should the defendant be held, as a matter of law, not liable, as regards the other physician, on account of the part the latter took in the case? The court thinks that it should not so rule. The defendant had already caused two or more exposures, when he had the other physician intervene and in his presence take another with the same machine, the defendant then resuming the same treatment with the same machine. The defendant's continuance of the exposure with knowledge of what the other physician had done tended to show an adoption of the latter's effort. Keeping in mind that it was the number of exposures, within a given time, made as these were, that may have been the cause of the plaintiff's injury, especially when considered with the defective machine and with the defendant's

knowledge of these things and of his presence when the other physician acted, it would seem to be unrighteous and unreasonable to absolve the defendant from liability for the other physician's negligence as a matter of law. It was a question for the jury. As to the salesman's part, the court finds less excuse for the defendant's contention, for the salesman was not a physician and made no pretense to the experience and skill of an expert in the medical profession.

The defendant claimed that he warned the plaintiff of the danger in more than two or three exposures in a given time, and that if the plaintiff insisted on them it would be at his risk. But while the plaintiff may have assented to more than the two or three exposures, yet, of course, he did not assent to a careless exposure, with a machine that was out of order. While there was evidence tending to show that he was warned against more than three exposures and assented to a greater number, he did not consent to negligent conduct in the manner of taking the exposures, or of the defects in the machine used by the defendant.

JUDD, E. S. The Results of Surgical Treatment of Exophthalmic Goiter. (*New York State Journal of Medicine,* September, 1920. Vol. xx, No. 9.)

In discussing the causation of the disease the author contends that there is always a hyperplasia of the thyroid; and that while it is not supposed to be the only tissue change, no case of exophthalmic goiter exists in which there is not this very certain and positive change. He suggests that it had best be grounded with toxemias, and that it is under the control of cellular changes that occur in the thyroid. When a part of the thyroid is removed the symptoms subside, and if they return they are always associated with an enlargement of the part of the gland which was not removed. In discussing treatment he contends that the disease occurs in attacks. If the patient is under a downward wave of the attack, that is, if the nervousness is increasing and the strength and weight decreasing, no surgery should be undertaken. He thinks that this has a very material bearing upon the recovery of the patient; but if they are carried over this climax by rest, increased elimination, etc., and perhaps ligation of the thyroid vessels, the acute stage may be passed and the patient prepared for surgical relief later.

The result of these palliative measures is often striking, especially following ligation, and there is a tendency to consider the patient cured because he appears to be much improved. It is always best to advise a thyroidectomy as soon as recovery is sufficient to make it safe, since they will be much better after the gland is removed, and the danger of relapse will be very materially reduced.

Until recently, we depended entirely on the clinical picture and physical findings by which to estimate the degree of toxicity in the cases of hyperthyroidism, but in the past few years it has been shown that the toxicity may be measured accurately by the changes produced in the basal metabolic rate. The basal metabolic rate is always increased in cases of hyperthyroidism, and decreased in cases of hypothyroidism. While some unknown factors may enter into the problem of hyperthyroidism the changes in the metabolic rate are characteristic and give an accurate method for the determination and estimation of the degree by thyroid toxicity.

Means and Aud, in a recent article, have shown in detail the influence of *x*-ray treatment. Their results were estimated largely by metabolic studies, and were compared with a series of cases in which surgical treatment had been given. They concluded that results from *x*-ray treatment are more satisfactory since there were no fatal cases, and that ultimately, especially as far as the metabolic rate was concerned, the results were about the same as in cases in which operation was done. The report is interesting and seems to show that the *x*-ray has some influence on thyroid activity.

The mortality following surgical treatment is due most often to increased hyperthyroid which occurs in spite of treatment. Dr. Judd reviews the conditions of 100 consecutive patients operated on in 1914. There was a mortality of 2 per cent. of this 66 per cent are free from disease after the operation, and 13.5 per cent show marked improvement, while 5.5 per cent show slight improvement. Eleven of the one hundred patients died after leaving the clinic. The series studied in 1909 show only 44 per cent cured. The difference between the number of cures in 1909 and 1914 is due to difference in technique.

Beck, Harvey G., and Evans, John. Comparative Study of Gastric Motility as Determined by the Ordinary Test Meal and Six Hour Barium Retention. (*J. Am. M. Assn.*, Vol. 73, No. 23, December 6, 1919.)

Our observations indicate that frequently when adhesions involve the pylorus and duodenum, the power of the stomach to empty itself is at first increased and later diminished. The degree of gastric acidity seems to have little or no influence on the amount of gastric contents after a test breakfast or six hour retention. No interpretation should be made on this point without studying the acid curve by the Rehfuss method of fractional gastric analysis. The motor function of the stomach can be determined by the complete removal of a standard test meal with the partial vacuum method. There is no constant relation between the motor function as determined by the test meal method and six hour barium. Six hour barium retention occurs after a motor meal if the stomach contents exceed 200 c.c. in fifty minutes or 150 c.c. in sixty minutes. The comparative results of the two methods are most uniform and constant in duodenal ulcer. Six hour barium retention occurs more frequently in adhesions involving the pyloroduodenal region than in either duodenal or gastric ulcer. There is little evidence to show that the secretory function has any influence on the motor function in pathologic conditions affecting the stomach and duodenum.

Subbel. Hydatid Cyst of the Lung Discovered by Radiography. (*Bulletins et Mémoires de la Société de Radiologie Médicale de France*, April, 1920.)

A man, age twenty, came for radiographic examination, with the following clinical findings: Modified respiratory sounds in the left apex; fremitus increased, vocal resonance increased. Patient had lost some weight, and had been spitting blood recently. Fluoroscopic findings were: Diminution of the light reflex in the left apex. Lessened transparency beneath the clavicle. Right light reflex normal, subclavicular region clear. At the level of the second rib in front, and 6 cm. to the right of the midline, was seen a shadow about the size of a two-franc piece, with regular and well defined borders moving with the respiratory movements. From the side, this shadow was seen to be 1½ cm. behind the anterior thoracic wall. Its shape, viewed thus, was circular, density uniform and borders regular. These characteristics suggested hydatid cyst. The patient then gave a history of having been closely associated with a young shepherd dog, which he had commonly carressed. Dogs are commonly the host of the tenia echinococcus. The complement fixation test of Weinberg was positive. Blood examination revealed numbers of Eosinophiles.

Lowell S. Goin, M.D.

THE AMERICAN JOURNAL OF ROENTGENOLOGY

Editor, H. M. Imboden, M.D., New York

VOL. VII (NEW SERIES) DECEMBER, 1920 No. 12

ADDRESS OF WELCOME*

By WILLIAM J. MAYO, M.D.

ROCHESTER, MINNESOTA.

MR. CHAIRMAN, Members of THE AMERICAN ROENTGEN RAY SOCIETY: I do not propose to take up your time in exactly the way your President has outlined, but rather to call attention to some of the important facts in connection with the specialty you gentlemen represent. I am free to say that the profession as a whole appreciates how much roentgenology is doing for the advancement of medical diagnosis.

Medicine has ever advanced under the sense of sight. In the operating room of Gray Turner, one of the brightest and most progressive younger surgeons of Great Britain, hangs a motto. At the top of this motto in large letters is the word "sight." Below in small type, "touch," and down at the bottom so it can scarcely be seen, "hearing." These three senses seem really to represent the manner in which we learn; the reason for it is simple.

The first of the special senses was the sense of taste which enables the primitive mouth to recognize food. Then came the sense of smell, that the mouth might be brought to recognize food with which it was not in contact. Both these senses are poorly developed in man. Then, for the protection of the living body, came hearing, and because dangers presented from behind, and from each side, as well as in front, the ears were placed on the sides of the head. In hearing man does not excel, in fact, he does not in this respect equal many of the so-called lower animals. But when the brain began to develop in man, it was with the development of the sense of sight, so that there are direct channels from all parts of the brain to the sense of sight. With most of us memory is visual. We reproduce in our minds the photographic picture of what we wish to remember. I can illustrate this by something I observed many years ago at a party given by my daughter, then eight years of age. A child was blindfolded, and two pieces of metal were struck together about eighteen inches from her head. I was amazed that the child could do no more than make a guess with regard to the direction of the sound. Children blindfolded could not distinguish a brother from a sister by passing hands over the face, thus showing the inaccuracy of the senses of hearing and touch.

Great advances in medicine were made

*Read at the Twenty-first Annual Meeting of THE AMERICAN ROENTGEN RAY SOCIETY, Rochester, Minn., Sept. 14, 1920.

by John Hunter, who with the aid of a primitive microscope reconstructed pathology. Following John Hunter, through the sense of sight and aided by the improved microscope and the culture tube, Pasteur developed the germ theory of disease which has brought us to the point where we are to-day.

The surgeon, when he explored the abdomen, brought to his aid the sense of sight, so that things otherwise obscure might be made known. It is the sense of sight that has permitted specialists in their study of the urogenital system to accomplish what they have. Roentgenologists have opened a new door through which we are to see things that never before have been seen by man.

In our appreciation of the *x*-ray I believe we have been led by the splendid work that was done by Roentgen to overlook the wonderful work of Sir William Crookes, but, it will be remembered that it was with Crookes' tubes that Roentgen worked. Crookes, with his heavy glass bulb exhausted the air and then made the electric attachments that gave us the *x*-ray. He saw atoms in action, and, as he says, "For the first time, we have reached the point in which we no longer can separate energy from matter."

I believe that we are in the primary stage, the infancy, of the *x*-ray. Its future is limitless. The *x*-ray extends man's capacity, it extends his understanding, because it produces pictures in his mind which he visualizes more clearly from day to day.

Because of our desire to apply to the diagnosis of disease the knowledge and the methods of all specialists we are practicing group medicine. Group medicine consists in giving to the sick the knowledge, skill, and experience possessed by the medical profession in common and by specialists.

One of the buildings in the course of construction in Rochester will be used for the purpose of maintaining 250 beds in which patients will be treated whose diagnosis is doubtful or in whom the indications for treatment are not clear, thus bringing to bear on their infirmities not merely the internist, the surgeon and the specialist, but all that physiology, bacteriology, physics, chemistry, and pathology have to offer by learned men in these sciences.

ADDRESS OF WELCOME*

By CHARLES H. MAYO, M.D.

ROCHESTER, MINNESOTA.

It is certainly a great pleasure to have you gentlemen stop off in Rochester on your way to your meeting place, and we who are not roentgenologists hope to learn a great deal even during your short stay.

There is something magnificent about the work in electricity, and yet it is only in its infancy. When we remember how much of benefit to the human race the *x*-ray has accomplished in a few decades, we may well wonder what the future has in store for a science that is so constantly and rapidly progressing. In the development of roentgenology a new branch has been established in medicine, thus aiding and encouraging departmental work in the diagnosis of disease.

The thought I wish to bring to your at-

*Read at the Twenty-first Annual Meeting of The American Roentgen Ray Society, Rochester, Minn., Sept. 14, 1920.

tention at this time is the fact that even though you are engaged in the highly specialized work of roentgenography, you nevertheless have a share in the responsibility, with all other medical men, of elevating the standards of medicine in general and of working along the lines of the prevention of disease. The best men in every town or city, no matter what their specialty may be, should interest themselves in public health measures. A medical man should be on the school board in every community; a medical man should be in every city council; a medical man who ignores these duties is not serving his own interests, the best interests of the profession, and certainly not the best interests of the community in which he lives.

ROENTGENOLGY IN THE MAYO CLINIC*

By R. D. CARMAN, M.D.

Section on Roentgenology, Mayo Clinic,

ROCHESTER, MINNESOTA.

IN the time allotted to this paper I can describe briefly only some of the technique employed in the *x*-ray laboratory. Roentgenology as practiced in the Mayo Clinic differs little from that practiced elsewhere. The most striking differences lie in:

1. The wealth of material available in the Clinic.
2. The simplicity of technique and the dispatch of examinations.
3. The organization and close affiliation with all other departments of the institution.
4. Surgery that proves or disproves the roentgen findings.
5. The making of a diagnosis, or description of a lesion or abnormality, when present, uninfluenced by clinical findings.
6. Uniformly arranged records covering every eventuality.

During the year 1919 the examinations made in the Department of Roentgenology numbered 50,668 as follows: kidney, ureter and bladder, 6,088; bone 12,129; chest, 17,301, and gastro-intestinal tract 11,825. In the Department of Urology 1325 pyelograms were made.

In regard to technique the effort has been toward simplicity, not, however, to the exclusion of anything essential. For example, in the examination of the urinary tract 8 by 10 inch plates are used with a core for compression having an aperture of 5 inches. The position of the plates is such that each exposure slightly overlaps the preceding exposure. To illustrate: One plate is used for each kidney area, one for the ureters high up, and one for the lower ureters and bladder combined. In thin persons, however, where there may be a movable kidney a 10 by 12 inch plate is substituted for the ureters. This exposure is made with a cone having a 7½ inch aperture.

All chest examinations are made stereoscopically with the patient standing and the plates shifted in the vertical position. If indicated, patients are also subjected to screen study.

Preliminary preparation of the gastro-intestinal tract is assured by written instructions issued to the patient by the referring clinician. The majority of patients come directly from the gastro-enterologist, after tubing and lavage which insures thorough evacuation of food bite and secretion in obstructive cases.

In esophageal examinations the patient is placed in the right anterior oblique vertical position; plates are made in the same posi-

*Read at the Twenty-first Annual Meeting of The American Roentgen Ray Society, Rochester, Minn., Sept. 14, 1920.

tion with the patient either recumbent or standing. The barium acacia mixture is used in this examination.

The double meal method is used in all gastric examinations, that is, the patient is given a motor meal, four ounces by weight, consisting of barium sulphate cooked in a cereal. This is taken with milk and sugar to taste six hours before the examination is made. During the intervening six hours the patient must, of course, abstain from food.

The examination consists of observation of the chest, after which the screen is lowered over the abdomen to note if there is residue in the stomach or obstruction in the small bowel, and so forth. The patient is then given an aqueous mixture of four ounces of barium sulphate, one dram of sodium bicarbonate, eight ounces of water, and syrup of raspberry sufficient to flavor; this is thoroughly mixed by a motor driven machine for from two to four minutes before taken.

While the patient is drinking this mixture the stomach is viewed to detect abnormalities. When the entire draught has been taken the stomach is palpated for possible tumors, the barium is forced into the duodenum to overflowing and any irregularity of contour is noted. Plates are made immediately after the screen examination and the diagnosis is made by comparing the plate and the screen findings. The patient does not return for further examination unless obstruction of the bowel is suspected or the findings suggest further study.

For the examination of the colon the patient has a preliminary purging by castor oil the day before examination and a cleansing enema early the next morning. Our preference at present is for the enema, as we believe that any lesion demonstrable by the ingested meal is equally well demonstrated by the enema, and that many early lesions not demonstrable by the ingested meal can be recognized by the clysma.

The enema consists of from six to eight ounces of barium sulphate, one pint of saturated solution of acacia, and condensed milk to make three quarts. An ordinary metal douche-can of this cacapity is suspended at an average height of 12 inches from the table connected by rubber tubing to a metal rectal tip which has just sufficient shoulder to insure its retention by the sphincter. A number of these are kept in the sterilizer and a fresh tip is used in each examination.

The patient lies on his back and a preliminary screen examination is made for evidence of any pathologic conditions. The enema is administered slowly and its progress is watched for filling defects. The patient's deep breathing assists in the passage of the fluid, especially in the region of the cecum and ascending colon. The fluid is allowed to flow until it is seen to pass the ileocecal valve. Areas of apparent filling defects are palpated deeply to rule out gaps from small gas-pockets, bone pressure, redundant loops, and so forth. Placing the patient in the prone position will often clear up an apparent filling defect. Plates are made with the patient on his back and in the prone position. The personnel of the department consists of a head, an associate, assistants, technicians, and clerks. A limited number of Fellows from the Mayo Foundation, which is affiliated with the graduate school of the University of Minnesota, are assigned to the department for duty for periods ranging from three months to the full term of three years.

Reports on the examinations of patients are delivered twice daily and a messenger service is maintained to deliver plates, on request, to any hospital or department of the clinic. View boxes have been placed in most of the departments, and clinicians frequently come to the roentgen laboratory to discuss findings.

Through the universal use of the patient's registration number on all records in the clinic, the correlation of clinical and laboratory findings is easily effected. In the study of the material constantly passing through the department all the information concerning an individual patient is placed in the general file with every facility to make it avail-

able. Statistical files covering many phases of medicine and surgery are maintained.

It has been the practice of the department for many years to have one member of the staff, usually the head, attend operations examined in the department. This offers an opportunity to compare the clinical history as it is read in the operating theater with the roentgen diagnosis and then to learn the operative findings. By this method we have been able to work out indirect signs which in our experience have proved as valuable as the direct signs in making a diagnosis and have also added materially to our knowledge of and confidence in the latter.

We must acknowledge here the splendid cooperation of the surgeons; without their skill, their experience, and their belief in the value of the x-ray much of the best of our work would have been impossible of achievement.

Typewritten copies of the surgical findings in all cases in which we have an interest are furnished the department to be added to its records.

The patient comes to our department with a referring card on which, in the majority of cases, is stated the examination required; a few of the cards may have a brief note on clinical findings; however, the roentgen diagnosis is made without reference to these clinical notes. When possible the diagnosis is made on roentgen signs, but in atypical cases only the character of the lesion or the abnormality is described.

While this independent method of examination has resulted in greater accuracy in the diagnosis of gastro-intestinal diseases because of the various influences affecting the gastro-intestinal tract, such as spasm, tonus, fright, anger, or muscular contraction, it does not hold true of other parts of the body where these influences cannot be brought to bear. Here we may use the clinical data in combination with the roentgen observations to form (1) a general syndrome on which the diagnosis is based; (2) as an index of the possibilities and probabilities in the case at hand and thus direct the examiner's particular attention to them, and (3) to prevent too hasty judgment, as in those cases in which the roentgen signs do not harmonize with the clinical facts, and in which a more careful review of these signs or a re-examination may show them to have been mistaken.

GRADUATE EDUCATION IN ROENTGENOLOGY *

By LOUIS B. WILSON, M.D.,

The Mayo Foundation,

ROCHESTER, MINNESOTA

YOUR president has asked me to speak on graduate education in roentgenology. As Chairman of the Committee on Graduate Medical Education of the Council on Education of the American Medical Association last winter I assisted in the investigation of graduate medical schools east and south of Minnesota. This investigation brought out certain facts which, with the results of our experience in the Mayo Foundation, may be of interest to you.

I think we may take it for granted that before beginning the special study of roentgenology a man should be thoroughly grounded in the fundamental medical sciences, chemistry, anatomy, physiology, pathology and bacteriology, that he should have had general training in clinical medicine, especially in clinical diagnosis, indeed a minimum of what is implied by graduation from a class A medical school, and at least one year's work in a good general hospital. Such a preliminary training would mean that the average person would be twenty-eight years of age before taking up his special training in roentgenology. He is then of course too old. Unless boys can get into college earlier there seems to be no way out of this dilemma.

Fellows in the Mayo Foundation who are selected with this preliminary training are found to be fairly well grounded in general medical work. They are likely to have been taught anatomy more from the purely morphologic standpoint than the functional, to be wofully inexperienced in performing necropsies, and to have little ability to marshall their knowledge of the several fields of medicine and make it available in finding out what is the matter with the patient. This latter defect may be due to the "air-tight-compartment" system of medical training by which each instructor imparts his subject without sufficient reference to other departments, while the student is not encouraged to discover the relationships between courses and their bearings on disease in the individual patient. Many of the men have more receptivity than initiative, the result of being taught too much and not having been permitted to find out enough for themselves. And, yet, initiative is a prime requisite of leadership in any field of medicine.

The first essential then in training such a graduate medical student in roentgenology or any other medical specialty is to throw him on his own responsibility and compel him to learn to utilize all his powers in diagnosis and treatment. To do this he must be placed in contact with patients and be made responsible for the diagnosis of their ailments. He must be made to dig rather than be crammed. His first work will probably be very superficial, and he must be compelled to be thorough. If serious defects in his preliminary training in any of the fundamental branches are discovered he must have an opportunity to remedy them. While his routine clinical work must be sufficient to give him good experience it must not be so much as to wear him out with the mere physical labor of it. He must be given time to think, to organize his observations, not on one patient alone but on groups of patients, so that he may get a scientific viewpoint of the conditions of disease. He must learn also how to analyze the observations of others, either his immediate associates or those with whom he becomes acquainted in the literature. In other words, he must become an observer who makes science of his observations.

Last, but not least, he must be relieved from serious financial worry while in training. Few graduate medical students are

*Read at the Twenty-first Annual Meeting of THE AMERICAN ROENTGEN RAY SOCIETY, Rochester, Minn., Sept. 14, 1920.

wealthy. Many of the more brilliant are already in debt. That distinctions should not be obvious all should be paid a living stipend. This will go far toward preventing the tendency to the "quick lunch counter" methods of short courses of a period which we hope is passing.

We are taking on a limited number of Fellows in the Mayo Foundation for training in roentgenology. Dr. Carman has opportunities for four such Fellows at one time in addition to those majoring in other clinical subjects who wish to take advantage of the demonstrations and instruction provided in the department. Forty-seven Fellows are taking roentgenology as their minor. Most of the Fellows majoring in roentgenology are taking morbid anatomy as their minor subject, which means that they spend about six months on the necropsy service during which time they personally assist in about 150 postmortems. One of the Fellows has spent some time in Cambridge, England, working on the physics of *x*-ray. The bulk of the time of Fellows majoring in roentgenology is spent in the *x*-ray diagnostic work, some in *x*-ray treatment, and some in radium treatment. Clinical demonstrations in the various diagnostic and laboratory sections are open to them. The extensive material in the pathologic museum, all of which is card-indexed and made easily available, is at their disposal for special study; so also are the histories and statistical data in the divison of records. The study and reference library is on the floor above the *x*-ray department and all graduate students are encouraged to familiarize themselves with the literature of their special field which is reviewed in the seminar of the department. Numerous opportunities are afforded for following patients to the operating rooms where *x*-ray diagnoses may be checked.

At the end of a minimum period of three years, the Graduate School Committee, which consists of representatives from the faculties of the Medical School of the University of Minnesota and of the Mayo foundation, all of whom take part in testing the candidate, may recommend him to the Board of Regents of the University of Minnesota as qualified to receive the degree of Master of Science in Roentgenology.

The basis of the candidate's recommendation is the evidence given during the three years in the Foundation that he is, first, a competent practitioner of roentgenology, second, that he has a mind capable of organizing his daily observations into scientific form, and, third, that he has a broad knowledge of the facts of roentgenology and the supporting fields of medicine. The standard by which his competency as a practitioner of roentgenology is measured is the certification of the roentgenologists with whom he has worked that they are willing to call him in consultation and to refer cases to him, indeed that they are willing to refer their own relatives to him for professional service. This is the most important test of his qualifications. He must show that he has a scientific mind by a properly prepared thesis, containing his analysis of a group of cases which he has had under observation in the Clinic, supplemented by an analysis of observations of other cases of similar kind recorded in the case histories of the Clinic or in the literature. His knowledge of the facts of roentgenology and supporting fields of medicine is tested by very thorough oral and written examinations.

The degree of Doctor of Philosophy in Roentgenology is reserved for those exceptional graduate students who have proved in addition to the qualifications required for the degree of Master of Science their special capacity for research work of a high order.

The attempt to put graduate work in roentgenology and in other fields of medicine on a university basis has now been in progress in the University of Minnesota for six years. The plan is not perfect, but it is being improved with experience, and we have unquestioning faith that if other universities follow the plan it will work out well in the end, and place all fields of graduate work in medical specialties on a much higher plane than they are at present.

TOPICAL APPLICATIONS OF RADIUM*

By H. H. BOWING, M.D.

Section on Radiotherapy, Mayo Clinic

ROCHESTER, MINNESOTA.

IN our application of radium in the Mayo Clinic we use the terms milligram hour, erythema dose, distance screening, and so forth.

Milligram hours must be defined in each case. The amount of radium used multiplied by the hours applied gives the number of milligram hours. Applying 50 mg. of radium for twenty hours is not the same as applying 20 mg. for fifty hours, although the total of milligram hours is the same.

The term erythema dose represents 1000 mg. hours of radium, delivered to a square inch of skin surface at one inch distance, filtered through the silver wall of the applicator and 2 mm. of lead. The universal round applicator containing 50 mg. of radium screened with 0.5 mm. of silver and 2 mm. of lead at one inch distance applied for twenty hours is considered an erythema dose. In the majority of cases no erythema develops. The erythema which occurs occasionally is transient. It usually responds readily to simple treatments.

The term "distance screening" indicates that some substance, such as cork, wood or gauze, has been interposed between the radium and the skin surface overlying the area to be radiated. The distance bears a relationship to the amount of radium used and the distance of the lesion beneath the surface of the skin.

Cancer of the breast, primary and secondary sarcoma, Hodgkin's disease, tuberculous adenitis, and splenomyelogenous and lymphatic leukemias respond to topical applications of radium and deep x-ray therapy.

Cancer of the Breast.—In treating a primary carcinoma of the breast with or without metastasis a thorough radiation is indicated before operation and radiation after operation as soon as convalescence permits. Patients in this group have received repeated radium and x-ray treatments when a general anesthetic was contra-indicated owing to some myocardial change, thoracic or renal complication. Our cases in this group are too few for statistical study, but the primary results are encouraging.

All patients with recurring carcinoma of the breast with or without metastasis improve under this treatment, at least ulceration and sloughing are prevented. Roentgenograms of the chest are taken before treatment in order to determine the depth of the metastasis.

An erythema dose is delivered to each square inch of skin surface overlying the primary or secondary growth. Should the area be less than one inch square, 500 to 900 mg. hours are given. The treatment is repeated every six weeks until no evidence of activity is demonstrable.

X-ray treatment is repeated every three weeks until eight or ten have been given; after a wait of three months it is determined whether further therapy is needed. In possible metastatic areas x-ray therapy is given.

Sarcoma.—The round-cell sarcoma responds very readily and the melanotic sarcoma very poorly to radium and x-ray therapy. The spindle-cell and giant-cell sarcomas respond more favorably than the melanotic type. In a majority of cases it is possible to treat only the secondary growth.

The involved areas are mapped out and an erythema dose of radium is applied to each square inch of skin surface. If the involvement is confined either to the chest cavity or to the abdominal cavity, radium is applied to the anterior surface of each and deep x-ray therapy is given through the posterior and lateral abdominal and thoracic walls by the cross-fire method. The com-

*Read at the Twenty-first Annual Meeting of THE AMERICAN ROENTGEN RAY SOCIETY, Rochester, Minn., Sept. 14, 1920.

bined treatment is repeated at intervals of three months if necessary.

Hodgkin's Disease.—The treatment of the acute and chronic cases of Hodgkin's disease is identical. The first type is less amenable to treatment on account of its rapid clinical course. The majority of the patients are treated for cervical, supraclavicular, axillary and inguinal glandular involvement with or without splenic enlargement. Roentgenograms are taken of the chest, abdomen and pelvis to ascertain the amount of involvement of the deep lymphatics.

Superficial lymphatic enlargements are mapped out and an erythema dose of radium delivered to each square inch of surface. If the nodules are discrete and small, 500 to 900 mg. hours of radium with distance screening are applied to the enlarged node. If there is splenic enlargement, six areas are mapped out over the splenic area and 50 mg. of radium in a universal round applicator screened with 2 mm. of lead at one inch distance are applied for periods of four hours each. If the roentgenogram shows involvement of the thoracic, abdominal, and pelvic lymphatics, deep *x*-ray therapy is applied in the respective areas.

Tuberculous Adenitis.—The simple type of tuberculous adenitis offers the best result. If suppuration is present, curetting or drainage may be necessary. The patient is supported with general hygienic and dietary measures. Hyaline or calcarious adenitis may be an end result following radiation.

An erythema dose of radium is applied to each square inch of surface covering the enlarged lymph nodes. Should the nodes be discrete and enlarged, 500 to 900 mg. hours of radium are applied. The dose is determined by the size of the nodes. The treatments are repeated every six weeks until all signs of activity have disappeared.

Leukemia.—More radium is given in cases of acute splenomyelogenous leukemia than in the chronic cases in order to put the patient in the chronic state as rapidly as possible. Satisfactory remissions are obtained in practically all cases.

The amount of radium used is 100 mg. in the acute cases and 50 mg. in the chronic cases. The radium is placed in a universal round applicator walled with 0.5 mm. of silver, with 2 mm. of lead as a filter at one inch distance. Six to eight areas are mapped out over the area of lymphatic or splenic enlargement. The time of each application is four and three hours, respectively. The treatment is repeated at weekly intervals until a series of three or four have been given. During the treatments the blood is examined. If the hemoglobin and red cells decrease, the treatment is discontinued and a six weeks' rest is given. All patients are supported medicinally. Dietary measures and daily activities are also controlled.

ROENTGEN EXAMINATION OF THE URINARY TRACT MADE OPAQUE *

By W. F. BRAASCH, M.D.
Section on Urology, Mayo Clinic,
ROCHESTER, MINNESOTA.

VOELCKER and von Lichtenberg first demonstrated, in 1906, the feasibility of outlining the renal pelvis in the roentgenogram by injecting the pelvis with an opaque medium. The value of this method was not appreciated, however, until several years later, when American observers developed the method to its present scope, and subsequently it was widely adopted.

The procedure was first used to outline the pelvis, later the ureter, bladder, and urethra. With the increase of the scope of the method, the original term of pyelogram became manifestly insufficient. As a term which will represent the roentgenographic demonstration of the entire urinary tract I should like to suggest "urography." Such a term would not interfere with the retention of the accepted terms referring to the different areas, namely pyelography, ureterography and cystography.

Urography entails unusual and highly specialized technical difficulties, and unless judicially employed it is not without great danger to the patient. Its use should, therefore, be confined only to the experienced urologist and roentgenologist, working in close cooperation. Furthermore it should be used only when the clinical diagnosis cannot be made without it. Urography is contraindicated (1) when the patient is in advanced age or greatly emaciated, (2) in cases of advanced bilateral renal disease, and (3) when it is apparent that surgical treatment will be of no benefit.

Extensive improvements have been made in recent years in the mediums employed in urography. The first medium suggested was a solution of colloidal silver termed "collargol." It was found, however, that the silver solutions were really not solutions, but suspensions, and that the undissolved silver particles acted as foreign bodies when injected into the kidney pelvis. Moreover, it was demonstrated that mediums injected into the renal pelvis frequently entered the tubules, the glomeruli, and the small capillaries. When the fine particles of silver became lodged in the tubules, they acted as foreign bodies and frequently caused infection. It is necessary therefore that mediums employed in urography should be true solutions and not suspensions. With this in view, Burns suggested a solution of thorium which overcame many of the objections to colloidal silver and still remains an admirable medium. Unfortunately, solutions of thorium occasionally have toxic effects and are difficult and expensive to prepare. Shortly afterward solutions of the iodids were suggested by Cameron, and later Weld used the bromids. These two mediums are now the most widely employed. The ease with which the bromids and iodids are prepared and their cheapness, together with the excellence of the shadows they cast, make them desirable. They may be slightly irritating to the mucous membrane, however, particularly if they are retained in the renal pelvis. In spite of the fact that these solutions are comparatively harmless, it is necessary to employ great care in the technique of their application. The medium should usually be introduced into the pelvis by the gravity method; it may be injected with a syringe only by an experienced urologist. Every precaution should be taken not to cause pain on injection. As a rule 5 c.c. of the medium will suffice and it is rarely necessary to employ more than 10 c.c. After the x-ray exposure is completed, it is advisable to remove the injected medium as completely as possible, particularly if there is evidence

*Read at the Twenty-first Annual Meeting of THE AMERICAN ROENTGEN RAY SOCIETY, Rochester, Minn., Sept. 14, 1920.

of ureteral obstruction. This may be accomplished by allowing the catheter to remain in the pelvis for some time and diluting with sterile water. Any medium, if allowed to remain in the renal pelvis, may be the cause of renal infection. It seems probable that this is the result of bacteria which in spite of every precaution are introduced by the medium. Bromid and iodid solutions, however, may cause irritation even without infection when retained in the pelvis, and considerable reaction in the renal tissue. In case the retained medium causes renal infection, it may be advisable either to consider an immediate nephrectomy or to insert a ureteral catheter into the pelvis and allow it to remain there. The formation of multiple cortical abscesses frequently noted in this condition is identical with septic nephritis and should be treated as such. Procrastination, in the hope that the acute process will subside, is of great danger to the patient, and it is seldom advisable to delay nephrectomy more than forty-eight to seventy-two hours after the first evidence of sepsis.

It is ten years since we began to employ urography in the diagnosis of disease conditions of the genito-urinary system, and it is appropriate that an inventory should be made of its practical value. The value of urography in selected cases of hydronephrosis, nephrolithiasis, pyelonephritis, neoplasm and anomaly is unquestioned. It should be remembered also that the demonstration of a normal pelvis may be of as much diagnostic value as the demonstration of one that is pathologic.

HYDRONEPHROSIS

A diagnosis of dilatation of the renal pelvis as the result of marked mechanical obstruction should usually be made without the employment of pyelography. The presence of residual urine in the renal pelvis can usually be determined if more than 15 c.c. of urine can be withdrawn with a syringe through a ureteral catheter or by the overdistention test; a pyelogram is then not necessary. If, however, the usual cystoscopic technique is insufficient to reveal the presence or absence of pelvic dilatation pyelography may be an important measure. This is particularly true in cases of moderate pelvic dilatation, and in cases of impassable obstruction to the renal catheter. The interpretation of the pyelogram in cases of hydronephrosis may be very difficult, due to (1) impassable obstruction at the ureteropelvic juncture, (2) dilution of the medium by retaining fluid, and (3) insufficient medium injected to outline the dilated pelvis. It may be difficult to distinguish between hydronephrosis and neoplasm when there is unfavorable obstruction at the ureteropelvic juncture. Occasionally dilution of the injected medium by urine retained in the pelvis will cause scattered areas which suggest neoplasm.

NEOPLASM

Pyelography is recognized as a frequent valuable aid in the diagnosis of neoplasm. When a pyelogram is followed by a marked reaction, as with hydronephrosis, an immediate nephrectomy is advisable since septic nephritis may complicate the neoplasm. Here again, the method should not be employed as a routine procedure, but only if the diagnosis is not possible without it. The differential diagnosis of epithelioma of the renal pelvis and tumor in the renal cortex may be difficult. A hydronephrosis, together with the deformity usually seen with neoplasm, suggests pelvic epithelioma. The greatest difficulty has been to distinguish between neoplasm and polycystic kidney. The character of the deformity may be identical in both conditions. As a rule, however, they are distinguished by the fact that a neoplasm is characterized by the retraction and narrowing of the calices, while polycystic kidney frequently has an abbreviation of one or more of the calices, and seldom any narrowing. It should be remembered, however, that when polycystic kidney is apparent from the clinical examination pyelography should not be employed. Not infrequently the medium

will not drain from the calices because of the obstruction caused by the dilated cysts, and cortical infection may ensue. Bilateral pyelography in cases of polycystic kidney is particularly contra-indicated.

NEPHROLITHIASIS

The purpose of a pyelogram in cases of nephrolithiasis is to identify and localize the shadow. As a methof of identification it is of considerable value, particularly in the differentiation of shadows on the right side which may easily be confused with gallstones. However, since the introduction of fluoroscopy at the time of operation localization of the stone is not of great value. Identification of shadows in the ureter by means of ureterography still remains the best method. The relation of a leaded catheter inserted in the ureter to a shadow in the ureteral area is too indefinite to be of accurate diagnostic value when the catheter is less than 1 cm. distant.

ANOMALY

Demonstration of pathologic complications together with anomaly of the kidney and ureter by means of urography is a valuable aid in their diagnosis. It must be remembered, however, that retention of a medium in a single kidney may offer serious complications. The demonstration of an anomalous position of a kidney, or of a fused kidney, can frequently be accomplished simply by the introduction of a lead catheter.

Distinguishing simple inflammatory dilatation from dilatation of renal tuberculosis is occasionally of importance. The extent of renal destruction as a result of chronic infection may often be appraised only by the demonstration in the pyelogram of marked inflammatory dilatation and cortical necrosis.

CYSTOGRAPHY

The clinical value of demonstrating the outline of the bladder, which is termed cystography, as an aid to diagnosis, is not fully appreciated. It may be of considerable diagnostic aid in the presence of vesical neoplasm, vesical diverticulum, and prostatic obstruction, particularly when a complete cystoscopic examination is impossible, because of excessive hematuria, intolerance, contraction of the vesical lumen, or impassable urethral obstruction. The existence of a vesical tumor may be inferred from the presence of a filling defect in the outline of the bladder. The extent and character of the filling defect may also determine the size and nature of the tumor. It must be remembered, however, that partial distention of the bladder, reflex spasm, presence of blood clots, and so forth, may cause error in interpretation.

Diverticulum.—The opening of a diverticulum of the bladder is very easily overlooked on cystoscopic examination, and the diagnosis may be possible only by means of a cystogram. In fact, even though the opening of a diverticulum is visible on cystoscopic examination, a cystogram is advisable because of the possibility of the presence of multiple diverticula. Since a cystogram taken at one angle may easily overlook the presence of a diverticulum, it is always advisable to make an exposure in the anteroposterior position, and at the right and left angles. This will render visible the outline of the diverticulum, which might otherwise be obscured by the overlying bladder. Further it is advisable to have the patient empty the bladder as completely as possible, and repeat the cystogram. A lead catheter coiled in the diverticulum is sometimes of value in determining its size. Diverticula of the urethra and urethrocele may also be determined by this method.

Prostatic Obstruction.—Occasionally for technical reasons it may be difficult to make a cystoscopic examination in the presence of prostatic obstruction. A large prostatic gland, particularly with median intravesical projection, will cause a filling defect of the bladder outline at the urethral opening. Occasionally, however, such an evident filling

defect may be caused by gas in the bowel, and failure to distend the bladder, and prostatic obstruction may be erroneously inferred.

CYSTO-URETEROGRAM

A cysto-ureterogram may be of some value in certain cases, particularly if there is marked inflammatory dilatation of the renal pelvis and ureter, and if the cystoscopic examination is unsatisfactory. The cysto-ureterogram is made after the bladder is filled with an opaque medium while the patient is in extreme Trendelenburg position. If the lower ureter and meatus are patent the medium will gravitate into the dilated ureter and occasionally into the renal pelvis. The method, however, is not without danger if the medium enters both renal pelves and is then unable to drain readily.

In conclusion, it may be said that urography is one of the most valuable aids we have in the diagnosis of lesions involving the urinary tract. Its limited application, and the difficult and dangerous technique unless carefully safeguarded, will restrict its use, but the method merits a wider employment, and, I believe, in the future will receive it.

BIBLIOGRAPHY

1. Burns, J. E. Thorium—A new agent for pyelography. *Bull. Johns Hopkins Hosp.*, 1916, xxvii, 157-164.
2. Cameron, D. F. Aqueous solutions of potassium and sodium iodids as opaque mediums in roentgenography. Preliminary report. *J. Am. M. Assn.*, 1918, lxx, 754-755.
3. Voelcker, F., and von Lichtenberg, A. Pyelographie (Röntgenographie des Nierenbeckens nach Kollargolfüllung). *München. med. Wchnschr.*, 1906, liii, 105-107.
4. Weld, E. H. The use of sodium bromid in radiography. *J. Am. M. Assn.*, 1918, lxxi, 1111-1112.

ROENTGENOLOGY IN DISEASES OF THE TEETH *

By BOYD S. GARDNER, D. D. S.

Section on Dental Surgery, Mayo Clinic,

ROCHESTER, MINNESOTA.

A FULL mouth roentgenogram is one of the important points in the examination of teeth. In the past we have been content to ray suspicious teeth only, but we now see the value of raying not only the teeth that can be observed clinically, but the spaces from which teeth have been removed without regard to the time that has elapsed since the extraction. In this manner it is possible to demonstrate that we have been overlooking pathologic conditions that may have existed for years in these spaces under artificial plates.

The full mouth roentgenogram makes it possible to distinguish the normal condition, and thus a comparison may be made in order to diagnose the abnormal, while a single film may leave us very much in doubt.

So far as the *x*-ray is concerned a rarefied area means only a loss of bone; therefore, in the extraction of teeth no distinction should be made between the large and small areas. Time is an important factor in the interpretation of dental films; it has been the experience in the Clinic that many teeth which show only slight evidence of infection in the roentgenogram have proved to be harborers of infection on laboratory experimentation and from the relief to the patient following removal.

It is also important to have the patient present when the full mouth films are diagnosed. It is obvious that a more complete diagnosis may be given if the clinical findings are checked with the *x*-ray evidence. In other words, it is important to put the ex-

*Read at the Twenty-first Annual Meeting of The American Roentgen Ray Society, Rochester, Minn., Sept. 14, 1920.

ploring instrument on the tooth to be sacrificed.

Another point of value is that the dental roentgenologist should observe the extraction of teeth that show definite pathologic conditions. With the so-called surgical removal of teeth it is possible to demonstrate conditions that were overlooked with the old technique of pulling the tooth.

It is just as necessary for the dental roentgenologist to observe end results in order to become efficient as a diagnostician as it is for the roentgenologist in gastro-intestinal work. Reports of dental examinations by the physician or the dentist cannot have much weight unless the end results are visualized at the time the dental films or plates are examined.

The medical profession is still somewhat opposed to the extraction of infected teeth, because the results have not always been satisfactory. In answer to their just criticism it may be stated that by the newer technique of removing teeth (surgical removal) the tooth with the pathologic condition is removed with the minimum of trauma and without injury to adjoining teeth. By this method the maximum of regeneration of bone is obtained by allowing the muco-periosteum to fall into the socket. It is as important to remove all the infected conditions about the tooth as to remove all of the tonsils.

OSTEOCARTILAGINOUS JOINT BODIES*

By M. S. HENDERSON, M.D.

Section on Orthopaedic Surgery, Mayo Clinic,

ROCHESTER, MINNESOTA.

THE subject of loose osteocartilaginous joint bodies appeals, I believe, to the roentgenologist as well as to the surgeon, and this is my excuse for presenting the subject briefly to you.

We have found loose osteocartilaginous bodies in the knee, the elbow, and the shoulder, the frequency of occurrence being in the order given.

In the knee these bodies seem to be formed in several different ways. Some persons have a peculiar condition, designated as a clinical entity, called osteochondritis dissecans. Koenig, years ago, described it and thought it due to a blocking of the end artery supplying an area in the internal condyle just back of the insertion of the posterior crucial ligament. He could give no explanation of why this artery became plugged. It is possible that the stress put on the posterior crucial ligament has something to do with the formation of loose bodies from this area. It is not uncommon to find both knees affected. The loose bodies are not numerous in osteochrondritis dissecans, rarely more than two or three. The symptoms are recurrent catching or locking, but they are less violent than when the derangement is caused by one of the semilunar cartilages, and often the patient can feel the body or bodies in different situations. Roentgenograms show the body or bodies, likewise a depression, particularly in the anteroposterior view, on the internal condyle near the insertion of the posterior crucial ligament (Fig. 1). The patients in this group are usually under forty years of age.

In certain persons portions or pieces of the marginal osteophytic growths due to hypertrophic arthritis may be broken off and wander about the joint, and, nourished by the joint fluid, increase in size (Fig. 2). There may be six or seven quite large and rough bodies. Roentgenograms show marked hypertrophic arthritis. The symptoms are similar to those in osteochondritis dissecans with the exception that the arthritis causes

more stiffness and soreness between the spells of locking. The patients in this group are usually more than forty years of age.

Occasionally a patient presents himself with a knee filled with osteocartilaginous loose bodies. On palpation the knee feels like a sac filled with marbles. The roentgenograms show the bodies, perhaps fifteen, twenty, thirty or more, but the joint surfaces look smooth. This condition is called osteochondromatosis (Fig. 3). The bodies are formed by the somewhat thickened synovial membrane, hanging in folds and teats of tissue, the latter at first fibrous, later becoming cartilaginous bulbs. As these cartilaginous bulbs increase in size, they are detached by their weight and become wandering joint bodies; they also, nourished by the synovial fluid, continue to increase in size. Strange to say, with removal of the bodies a cessation of the process seems to occur. In the embryo the joint surfaces and the synovial membrane are developed from the same layer of mesial blastema and it is probable that the condition is brought about by some incomprehensible reversion or perversion of tissue. In one of our cases the condition was associated with a tumor in the lower end of the femur which on exploration was pronounced chondroma. The tumor recurred; it then proved to be more cellular and was pronounced chondrosarcoma. Amputation was done but the patient died in less than a year with multiple metastasis in the lungs. We might well consider osteochondromatosis to be a benign neoplasm.

The elbow is not infrequently the site of loose bodies. Usually a history of trauma sustained many years before may be elicited. The symptoms are milder than when the bodies occur in the lower extremities. Invariably there is loss of extension with occasional locking or catching. The roentgenogram may show only two or three bodies, or it may show twenty, thirty, or more (Fig. 4). As in the knee, some of the bodies may be due to hypertrophic arthritis, but so far as I know there is no condition analagous to the osteochondritis dissecans found in the knee. I have seen a number of patients, however, who at operation on the elbow presented the typical picture of osteochondromatosis. The fact that the symptoms produced by loose bodies in the elbow are less disabling than a similar condition in the knee is probably the reason that more cases are not observed. If

Fig. 1. Case 142135. Osteochondritis Dissecans. Two loose bodies in the intercondylar notch which arose from the area marked in the internal condyle.

Fig. 2. Case 108373. Hypertrophic Arthritis of Twenty Years' Duration. Loose body in the suprapatellar pouch.

more roentgenograms were taken of elbows showing limitation of extension, I believe we should be astonished at the number in which loose bodies would be found.

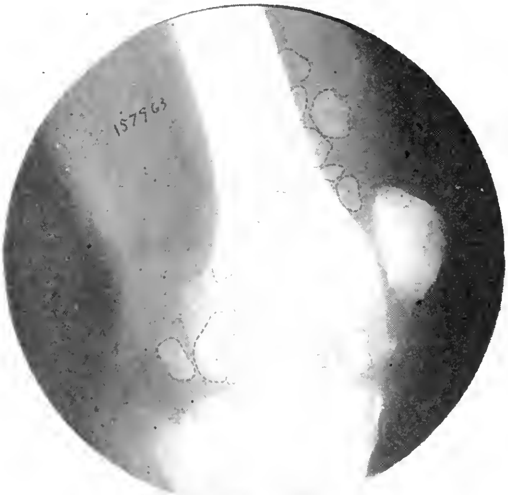


Fig. 3. Case 157963. Loose Osteocartilaginous Bodies in the Knee due to Osteochondromatosis.

We have observed loose bodies in the shoulder joint in one patient only (Fig. 5). This patient was a well developed young woman of twenty who for eight years had suffered from irregular spells of pain in the shoulder gradually increasing in severity and frequency. The pain was undoubtedly produced by the catching of the bodies between the joint surfaces. Stiffness and soreness followed attacks. Ten good sized bodies were removed through a posterior incision and a roentgenogram taken afterward showed the joint to be free. About one year later there was a recurrence of symptoms and a roentgenogram showed shadows which I believe may be of reforming bodies. A mild hypertrophic arthritis in the joint did not appear sufficient to be responsible for the formation of the bodies. So far as I could ascertain, there was no evidence of osteochondromatosis or other abnormality, and I was, therefore, at a loss satisfactorily to account for the condition.

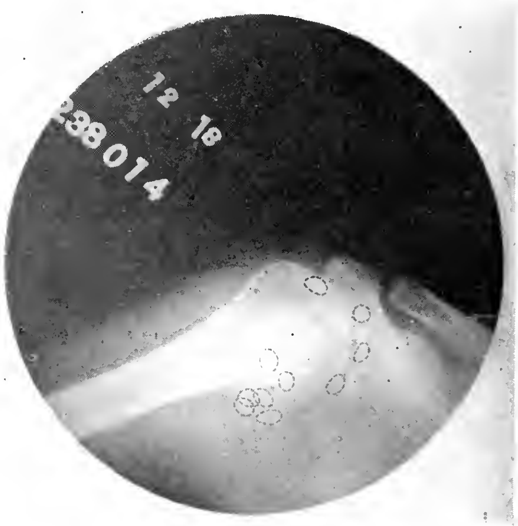


Fig. 5. Case 238014. Loose Osteocartilaginous Bodies in the Shoulder Joint.

Fig. 4. Case 126099. Loose Osteocartilaginous Bodies in the Elbow Joint.

Occasionally in patients suffering with tabes dorsalis loose particles occur in Charcot joints, but they are not free bodies and I have not seen mechanical derangement produced by them. I did not, therefore, consider them in this discussion.

CHRONIC GASTRIC ULCER AND GASTRIC CARCINOMA*

A STUDY OF 507 SIMPLE CHRONIC ULCERS AND 895 CARCINOMATOUS ULCERS**

By WILLIAM CARPENTER MacCARTY, M.D.

Section on Surgical Pathology, Mayo Clinic

ROCHESTER, MINNESOTA.

IN spite of the fact that many articles have been written, and much discussion has occurred, there are the three following questions still asked by members of the medical profession: 1. Does carcinoma develop on chronic gastric ulcers? 2. What percentage of chronic gastric ulcers become carcinomatous? 3. Does carcinoma develop in the base or border of a chronic gastric ulcer? These are asked so frequently that it seems in order to restate the facts which have been observed repeatedly in the study of a large series of fresh resected or excised gastric specimens. The facts have been stated before; and they have been illustrated by photographs of gross and microscopic specimens. The facts should be reduced to principles which may be plainly stated and diagrammatically illustrated.

1. Ulcers of the stomach may be divided into two great groups, acute ulcers and chronic ulcers.

2. Chronic ulcers of the stomach may be divided into two great groups, simple gastric ulcers and carcinomatous ulcers.

3. Simple and carcinomatous chronic gastric ulcers occur as single or multiple lesions (Fig. 1), large or small, shallow or deep lesions (Fig. 2), in any portion of the stomach, but they usually occur near the pylorus (Fig. 3) in the lesser curvature or posterior wall, although they do appear rarely in the anterior wall and greater curvature (Fig. 4).

4. There are two portions of gastric ulcers of interest and importance to pathologists, clinicians, surgeons and patients. These are the borders and the base of the crater (Fig. 5).

5. The base of the crater of a simple or carcinomatous ulcer may involve one or more coats (Fig. 6).

6. Chronic ulcers, associated with carcinoma, always involve the mucosa and usually one or more of the other coats.

7. One finds chronic gastric ulcers in

**

	Carcinomatous Ulcers	Simple Chronic Ulcers
1904	1	
1905	36	4
1906	29	10
1907	27	8
1908	42	13
1909	45	13
1910	47	21
1911	45	17
1912	45	32
1913	59	37
1914	68	39
1915	70	40
1916	49	39
1917	84	60
1918	62	61
1919	105	52
1920 (to Oct. 1)	84	61
	895 Total	507 Total

*Read at the Twenty-first Annual Meeting of The American Roentgen Ray Society, Rochester, Minn., Sept. 14, 1920.

which there are no microscopic or macroscopic signs of carcinoma; the lining epithelial cells of the gastric tubules are "columnar" and practically equal in size, their long axes being parallel; the nuclei are ovoidal and of about the same size, being about one third the volume of the whole cell (Fig. 7, A); the tubules may be found distorted; there is usually a lymphocytic infiltration of one or more coats; there is always necrosis of the tissue in the base of the crater regardless of the coat involved; the general trend of the scar tissue is perpendicular to the surface of the crater.

8. One finds chronic gastric ulcers which answer the exact macroscopic and microscopic description of simple chronic gastric ulcers plus one visible difference, that is, the replacement of some or all of the "columnar" epithelial cells of the gastric tubules by ovoidal or spheroidal cells, the nuclei of which are about one half the volume of the cell and contain one or more definite and distinct spheroidal nucleoli; these replacing cells vary somewhat in size and their long axes are not parallel; the cells themselves, are morphologically indistinguishable from cells which are definitely known to be carcinomatous; the replacing cells in this group of ulcers are intratubular (Fig. 7, B.).

9. One finds chronic gastric ulcers which answer the macroscopic and microscopic description of chronic ulcers, just described, plus the presence of the spheroidal or ovoidal cells in the stroma (Fig. 7, C). They are sometimes only in the mucosa.

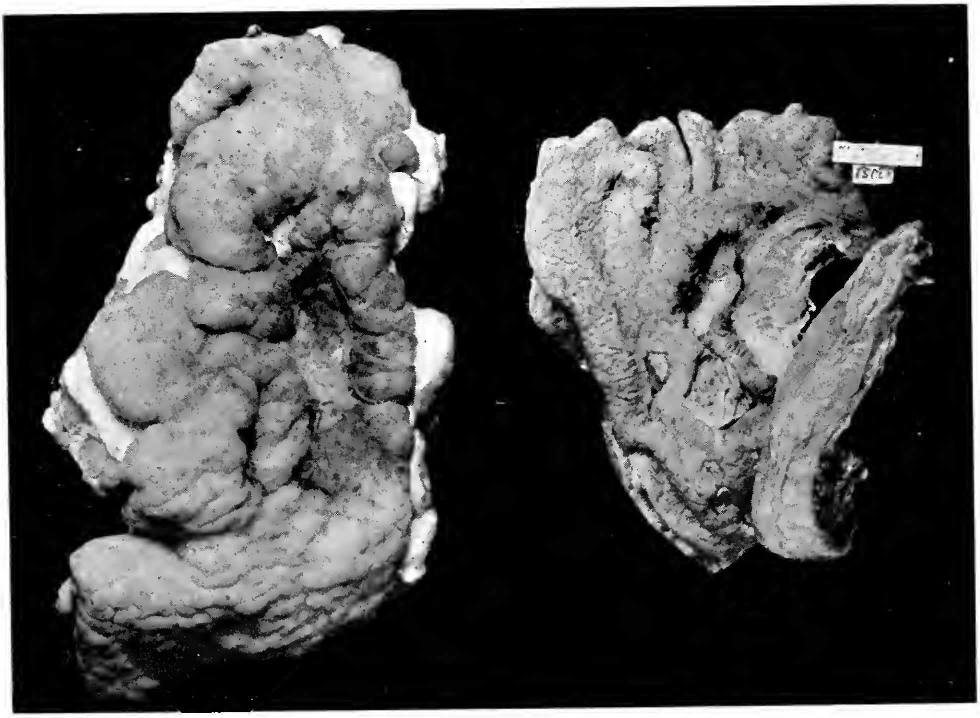


Fig. 1. Photographs of Portions of Two Stomachs, showing multiple chronic gastric ulcers.

10. In all cases which have been studied, if the undifferentiated or partially differentiated ovoidal or spheroidal cells are found in coats other than the mucosa they are always found in the mucosa. The reverse of this is not true. Whenever these cells are found in the base of an ulcer they are always present in the mucosa. The reverse of this is not true. When the cells are found only in the mucosa and sometimes in the mucosa, submucosa, muscularis and subserosa the

gross appearance of the ulcer is not always altered.

11. Chronic gastric ulcers larger than 2 cm. in diameter are usually but not always carcinomatous.

These being facts which can be confirmed by any large series of specimens studied carefully, there are certain practical deductions which may be logically and hence scientifically drawn.

1. If the surgical pathologist cannot distinguish always grossly simple chronic gastric ulcers from carcinomatous gastric ulcers, it is impossible for surgeons, roentgenologists and clinicians to make the differentiation with their lesser instruments of observation, there being no specific clinical or laboratory test for early cancer.

2. Every patient harboring a chronic gastric ulcer has the possibility of also harboring a carcinomatous gastric ulcer, and the differentiation must of necessity be made by the surgical cyto-pathologist, early cancer being a microscopic lesion. In a series of 475 gastric cancers studied, 52.6 per cent were diagnosed clinically positively, 22.7 per cent were diagnosed clinically carcinoma with a question mark, 3.1 per cent were diagnosed clinically "tumor," 2.7 per cent were diagnosed clinically "pyloric obstruction," 8 per cent were diagnosed clinically gastric ulcer with a question mark, and 3.1 per cent were diagnosed clinically "explore." The remaining 7.8 per cent were diagnosed clinically duodenal ulcer, appendicitis, or cholecystitis with or without stones. These figures are presented merely to show just what percentage of times the correct differentiation can be made clinically; they do not represent the clinical efficiency in so far as the welfare of the patient is concerned, because the clinicians who made the pre-operative diagnoses always gave pre-operative instructions, in all cases making possible the positive determination of what condition was present at operation. All patients had the benefit of physical examination, laboratory tests, *x*-ray examinations, surgical exploration, and immediate microscopic examination during operation. The figures merely prove the logic; that is, if the pathologist with the specimen in his hand cannot make the gross differentiation of the simple chronic ulcers and carcinomatous ulcers in a large percentage of specimens, such differentiation should not be expected of the clinician, surgeon and roentgenologist.

3. The surgeon and pathologist can always make a very fair macroscopic guess as to the nature of the ulcer from its size by virtue of the fact that most chronic gastric ulcers larger than 2 cm. in diameter are carcinomatous. The converse of this is not true, because many chronic gastric ulcers, smaller than 2 cm. in diameter, are carcinomatous.

4. The roentgenologist, who, by fluoroscopic or other means, can determine the diameter of an ulcer, even approximately, may also guess that a lesion larger than 2 cm. in diameter is carcinomatous.

The facts herewith presented are also of value in answering the three questions in the introduction. The first, "Does carcinoma develop on chronic gastric ulcer," cannot be answered because there are no positive or negative facts regarding development visible in the study of simple or carcinomatous gastric ulcers. No one has experimentally produced a chronic gastric ulcer and then produced a carcinoma in that experimental ulcer. The second, "What percentage of gastric ulcers become carcinomatous," cannot be answered by virtue of the fact that it cannot be shown positively that carcinoma develops in an ulcer. The third, "Does carcinoma develop in the base or border of chronic gastric ulcers," cannot be answered for the same reason that the second question cannot be answered. The fact that these questions cannot be answered does not decrease our efficiency in dealing with chronic gastric and carcinomatous gastric ulcers. The great and important practical questions are: 1. Is gastric carcinoma associated with chronic gastric ulcer? Answer—Yes. 2. Is the association of the two conditions sufficiently frequent to be of importance? An-

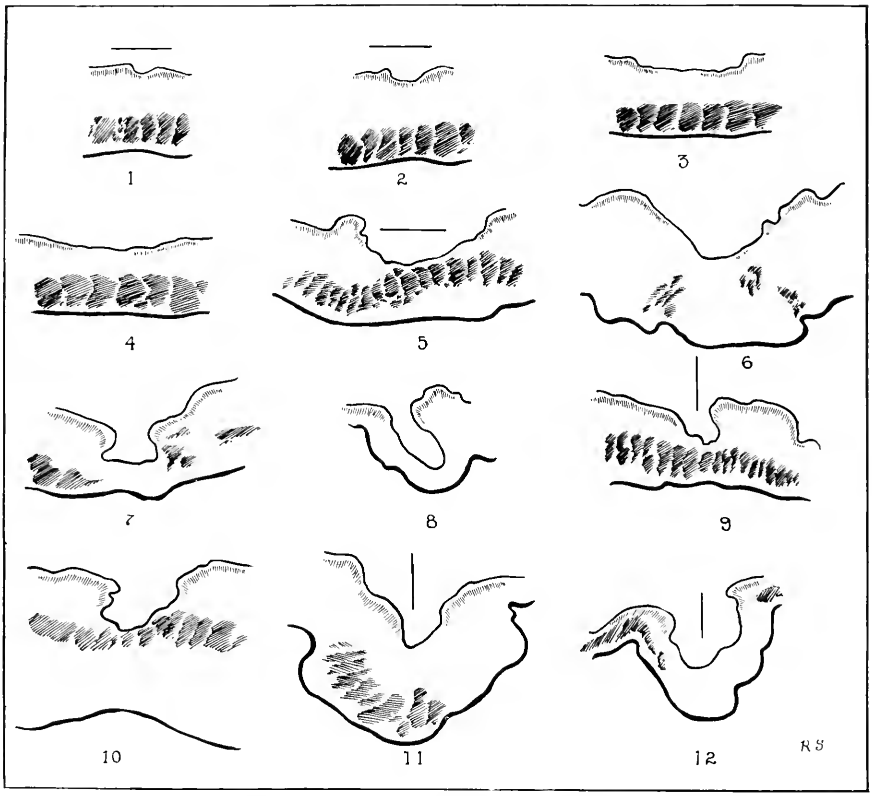


FIG. 2. DIAGRAM MADE FROM DRAWINGS OF GROSS SECTIONS OF SPECIMENS SHOWING VARIOUS SHAPED CRATERS OF CHRONIC GASTRIC ULCERS. The drawings are made to the same scale and the straight lines represent one centimeter. The mucosa and muscularis are shown by shading.

swer—Yes. 3. Can we state always clinically positively whether a gastric ulcer is or is not carcinomatous? Answer—No. 4. At exploration can we always state grossly whether a gastric ulcer is or is not carcinomatous. Answer—No. 5. Without the power of always grossly differentiating simple chronic gastric ulcer from carcinomatous ulcer, and positively knowing that a chronic gastric ulcer actually exists, what positive logical practical advice can be given? Answer—Consider the possibility of a chronic gastric ulcer being carcinomatous; excise or resect the ulcer and submit the specimen to a well trained surgical cyto-pathologist. 6. In view of the facts regarding the frequent association of carcinoma with chronic gastric ulcer, and our inability always grossly to differentiate the two conditions, what would we want to have done therapeutically if we possessed the ulcer, especially in view of the fact that extensive removal of a malignant neoplasm such as carcinoma has been demonstrated repeatedly to be the only known posi-

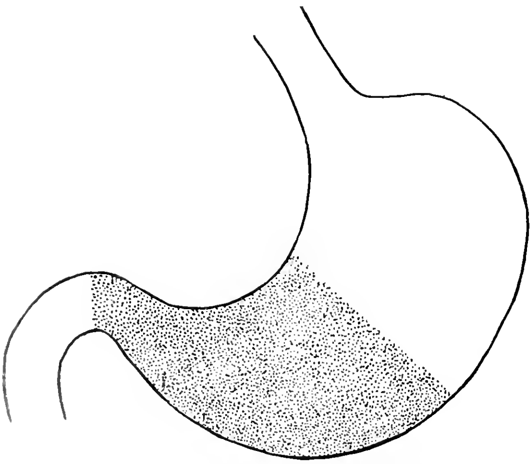


FIG. 3. DIAGRAM OF THE STOMACH showing the area (shaded) in which simple and carcinomatous gastric ulcers usually occur.

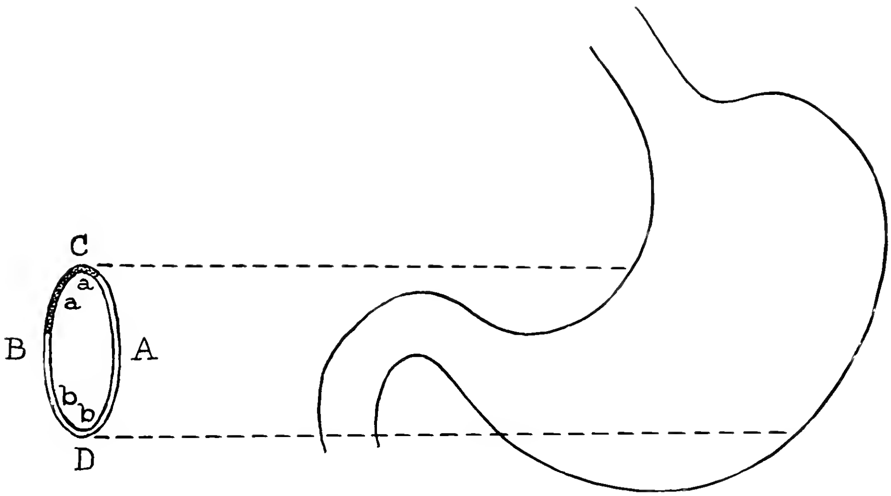


Fig. 4. Diagram of the Stomach showing a Projected Section of the Organ. A, anterior surface; B, posterior surface; C, lesser curvature; D, greater curvature; a, the most frequent location of chronic gastric ulcers (simple and carcinomatous); b, occasional location of chronic gastric ulcers (simple and carcinomatous).

tive means of combating the advance of such a devastating growth? Answer—Most of us would want our ulcer widely resected if possible. 7. What have been the results of resection of carcinomatous chronic gastric ulcers? Answer—Some of them, even with extensive glandular involvement, have lived nine and ten years after the resection. 8. Do we know which cases will live nine or ten years? Answer—No; but in our experience patients presenting specimens showing a combination of partial differentiation of the cancer cells plus extensive lymphocytic infiltration, have lived 148 per cent longer than those without partial differentiation and extensive lymphocytic infiltration. There are, however, so many factors connected with resistance to cancer that, with our present knowledge, we cannot always accurately prognosticate.

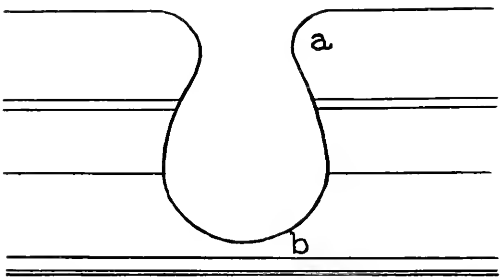


Fig. 5. Diagram showing the Two Points which have been claimed for the Starting Points of Cancer of the Stomach. a, the border, the latter being the point in which the earliest changes have been found in my experience; b, the base of the ulcer.

While the whole problem of cancer is far from having been settled, there are some things concerning the relation of chronic

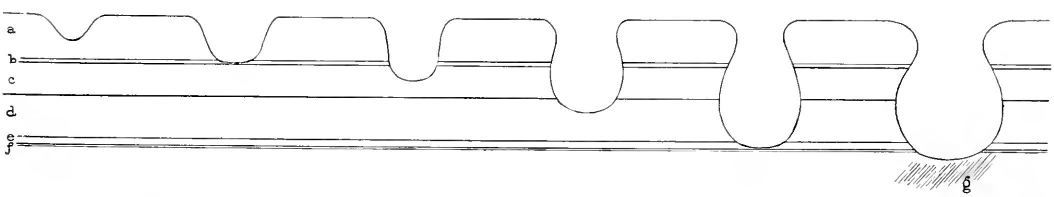


Fig. 6. Diagrams showing Extensions of Ulcers into the Various Layers or Coats of the Stomach. a, mucosa; b, muscularis mucosae; c, submucosa; d, muscularis; e, subserosa; g, some neighboring structure involved in the base of an ulcer.

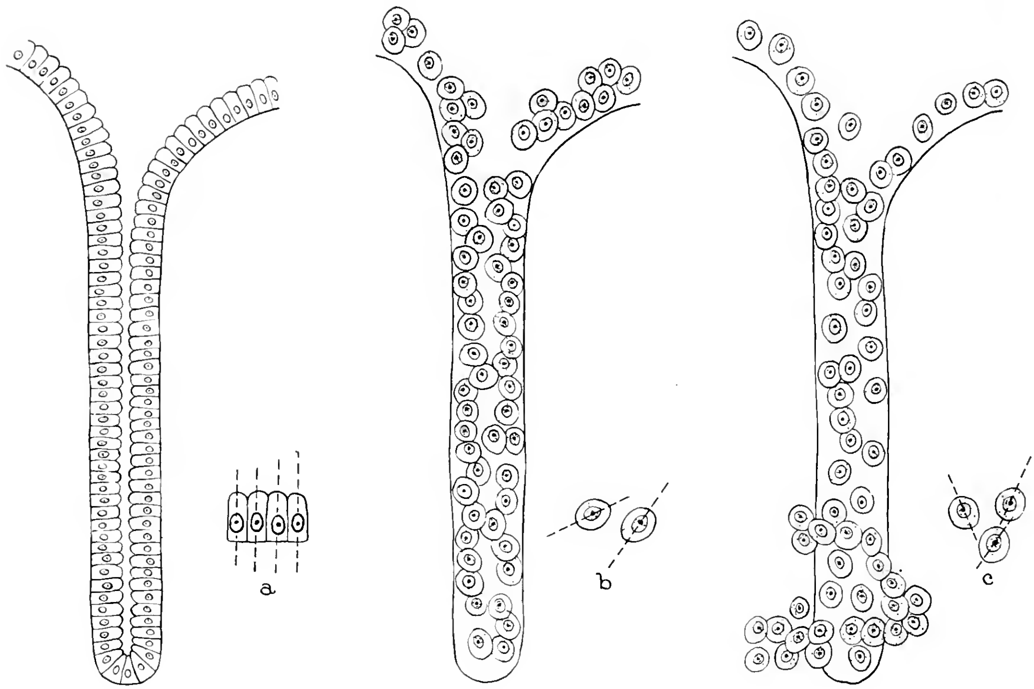


FIG. 7. DIAGRAMS OF THE CYTOLOGICAL PICTURES FOUND IN THE MUCOSA OF CHRONIC GASTRIC ULCERS. A, the normal gastric tubule with columnar epithelium, the long axes of which are parallel. a, the individual cells lining a normal gastric tubule; the nuclei of the cells are about one-third the volume of the whole cell. B, a gastric tubule found in the mucosa of some chronic gastric ulcers; the columnar cells are replaced by ovoidal or spheroidal cells containing nucleoli; the long axes of the cells are not parallel; the nuclei are about one-half the volume of the cells (a); C, a gastric tubule sometimes found in the mucosa of chronic gastric ulcer; the cells are similar if not identical with the cells in tubule B but they are also found in the stroma.

gastric ulcer and gastric carcinoma which are known and these I have attempted to state systematically, clearly and briefly. These have been frequently shown to be facts and may be confirmed by other large series of specimens.

LITERATURE CONTAINING DETAILED STUDIES OF SIMPLE AND CARCINOMATOUS GASTRIC ULCER.

1. MACCARTY, W. C. Pathology and clinical significance of stomach ulcer. From a study of the material from 216 gastrectomies for ulcer, ulcer and carcinoma, and carcinoma. *Surg., Gynec. & Obst.*, 1910, x, 449-462.
2. MACCARTY, W. C., AND BLACKFORD, J. M. Involvement of regional lymphatic glands in carcinoma of the stomach. *Ann. Surg.*, 1912, lv, 811-843.
3. MACCARTY, W. C., AND BRODERS, A. C. Chronic gastric ulcer and its relation to gastric carcinoma; review of six hundred and eighty-four specimens. *Arch. Int. Med.*, 1914, xiii, 208-223.
4. MACCARTY, W. C. Studies in the etiology of cancer. IV. Notes on the regularity and similarity of cancer-cells. Collected papers of the Mayo Clinic, Philadelphia. Saunders, 1914, vi, 600-602.
5. MACCARTY, W. C. The histogenesis of cancer of the stomach. *Am. J. Med. Sc.*, 1915, cxlix, 469-476.
6. MACCARTY, W. C. The pathologic reasons for the legitimate error in *x*-ray diagnosis of gastric carcinoma and ulcer. *Am. J. Roentgenol.*, 1917, iv, 67-73.
7. MACCARTY, W. C. Cancer's place in general biology. *Am. Naturalist*, 1918, 808-818.

PRE-OPERATIVE AND POSTOPERATIVE X-RAY IN CARCINOMA OF THE BREAST*

By DOUGLAS QUICK, M.B. (Tor.)

Assistant Surgeon, Memorial Hospital

NEW YORK CITY.

In the treatment of cancer of the breast the profession is now divided into three main groups: (a) Those confining their efforts to surgery alone; (b) those resorting to surgery first and following the radical operation with *x*-ray treatment, and (c) a small but increasing number who use *x*-ray treatment as a preliminary procedure followed by a complete surgical removal of the breast and then thorough postoperative radiation.

It is in the hope of enlarging the latter group that this paper is presented.

During the last half century the improvements in surgical technique, in diagnosis, and in the selection of cases has done a great deal to advance the treatment of mammary cancer. The statistics of the surgical treatment alone are, however, far from reassuring; and since the surgical operation for removal of the breast has reached a high state of technical perfection, it leaves much to be hoped for from other agents.

That this hope has been partially realized is evident from the voluminous reports in the more recent literature. Comparatively few of the more recent workers have quoted definite statistics, probably because of lack of sufficient time. Boggs [2] states that recurrences may be prevented in 25 to 50 per cent of cases by proper postoperative radiation. Pfahler [3a] believes that the end results can be improved at least 25 per cent by "thorough, competent, postoperative *x*-ray treatment." Todd [4] in 1916 reported that for the previous three years he had been using *x*-ray as a postoperative measure and that during that period he had not lost a patient nor had he had a recurrence. Deaver [3a] has reckoned the prognosis at 25 per cent better when postoperative radiation is used. In addition to these there are many other reports endorsing the value of *x*-ray as a postoperative measure of importance.

Other workers, recognizing the benefits thus far conferred, attempted to add to the efficiency of the *x*-ray treatment by exposures into the open wound at the time of the surgical operation, the immediate object being the control of implantation metastases. Here, as in other fields of roentgen therapy, Pfahler [3b] was one of the pioneers, and speaks highly of the method from both a theoretical and a practical standpoint. He credits Dr. Foerster of Milwaukee with being the first to use the method. Morton,[5] as far back as 1911, advocated the same method, and Holding [6] did a great deal of work along the same line, with excellent results.

The striking effect of *x*-ray on the generative organs has been made use of to simulate in part the older surgical procedure of castration as an aid in controlling the recurrences and metastases of mammary cancer in women not yet past the menopause. Knox [7] favors this procedure and states that it is done at the Freibourg Clinic. Pfahler [5c] quotes Theilhaber as advocating it, but states that while he considers it worthy of a trial, he has had no experience from the technique. The writer feels called upon to say that he has seen no good from either castration or the production of a premature menopause by *x*-ray, and that any apparent benefit derived from the latter treatment is, in his opinion, due to the control of lower abdominal metastases from direct radiation rather than to any indirect effect produced through the ovaries.

It will at once be noted that all measures previously mentioned interfere in no way with the surgical procedure. The precedent against immediate surgical intervention,

*Thesis presented with application for membership in The American Roentgen Ray Society, 1920.

once a clinical diagnosis of mammary cancer has been made, has not been questioned or interfered with.

In view of the surgical statistics of results of operation alone, and in the face of the voluminous reports of benefit conferred by *x*-ray in the inoperable and recurrent cases, as well as in the postoperative cases, is it necessary or wise to observe this surgical precedent further, provided added safeguards by some preoperative treatment can be established?

That *x*-ray stands first in offering this added safeguard also is quite evident from our mass of knowledge of its action. As Pfahler [3d] has expressed it in discussing the value of *x*-ray in inoperable cancer of the breast, it "offers considerable hope of a cure in some cases, relief from pain and discharge in others, prolongation of life in many and some benefit in practically all." Von Angerer [6] has noted that the rays inhibit the growth of the tumor cells and has demonstrated that they can cause involuntary changes in the tumors or transform them into less malignant ones. Handley [3e] found that a radiant treatment of two or three weeks' duration had a direct selective effect on the cancer tissue, consisting of a primary injury to the cancer cells which led to a disturbance in growth, lack of mitosis, giant-cell formation, and, to a certain degree, to changes in the character of the cells. Bythell and Barclay [9] have treated some primary cases for three or four years with *x*-ray alone, keeping them in check and apparently preventing metastases. This latter observation relative to the apparent prevention of metastases is as important as the direct destructive effect on the malignant cell, if not more so. It may be due in part to this destructive effect, but not entirely. The *x*-rays exert a very marked effect on he endothelial cells forming the walls of the lymphatics, and in that way tend to block the main channels of dissemination through atrophy. Pre-operative radiation offers still more; by taking advantage of it some inoperable cases are rendered operable. Newcomet [10] has mentioned several permanent cures of this type, and Holding [6] has reported similar instances.

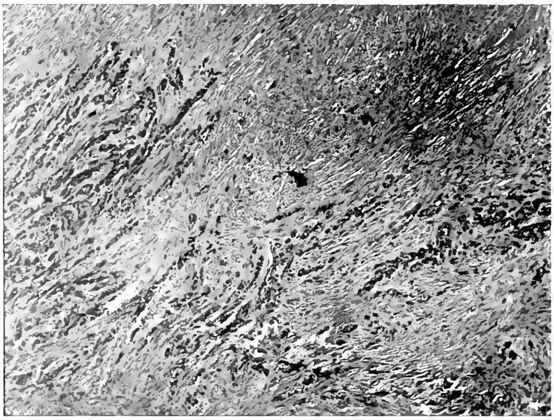


Fig. 1. x60: Breast Removed 16 days after Completing *x*-ray Cycle.

Fig. 2. x60: Breast Removed 28 days after Completing *x*-ray Cycle.

In our own series of cases one may be cited as an example. A woman thirty-nine years of age had noted a nodule in the lower inner quadrant of the left breast for four years. Following the birth of a child, fourteen months previous to her admission to the hospital, this mass began to enlarge and the skin over it became red and fixed. At the time of admission the mass, which measured 2½ cm. in diameter, was firmly fixed to the ribs and intercostal muscles beneath it, while the skin over it was reddened, fixed and retracted. A chain of glands up to 1½ cm. in diameter was palpable beneath the

pectoral fold up to the apex of the axilla. One definite supraclavicular gland was palpable near the inner end of the clavicle. Radiographic examination of the chest was negative and on the right side there was no palpable evidence of disease. This patient was given one complete cycle of massive x-ray therapy delivered at cross-fire through multiple portals of entry over the breast and all regional glandular areas. This required four days. During the next four weeks the primary mass became smaller and movable; the sub-pectoral and axillary glands decreased in size, and the supraclavicular gland disappeared entirely. At the end of this time a complete breast amputation, with removal of the axillary lymphatics, was done. As soon as the patient was able to be out of bed another cycle of treatment was begun and has been repeated four times since. It is now nearly two years and the patient presents no visible or palpable evidence of disease. Microscopic examination showed a malignant type of fibro-carcinoma, the cells of which indicated marked degenerative changes.

The favorable effects of *x*-ray on recurrent and metastatic skin nodules of mammary cancer, carcinoma "en cuirasse," and Paget's disease of the nipple, noted by Knox,[7] Archibald,[11] Pfahler,[3f] Ochsner and Percy,[12] Newcomet,[10] and many others, suggests an added reason for preoperative radiation. A study of the superficial lymphatic drainage of the breast very strongly suggests that many of the regional skin recurrences, commonly considered implantation metastases, are really direct extensions to the skin through the elaborate channels of this superficial lymphatic plexus. The treatment into the open wound was advanced primarily to care for these metastases, but it at once becomes apparent that they can be better handled before operation. The exposures can be made much more accurately, a wider surface can be covered, wound infection is obviated and not only is the destructive effect on malignant cells produced, but atrophy and partial obliteration of the lymphatic channels is brought about prior to operation. Another factor of importance must not be disregarded, in being able to dispense with this treatment at the time of operation —to be of value it cannot be carried out in less than 15 or 20 minutes, and the patient meanwhile remains under the influence of anesthesia awaiting the final steps of the surgical operation. That this is a detriment to the patient was shown in 1916 by Gaylord,[1a] who proved experimentally that prolonged anesthesia and hemorrhage reduces the resistance to cancer.

Influenced by these considerations, we were led to adopt the preoperative *x*-ray treatment of carcinoma of the breast at the Memorial Hospital between two and three years ago.

Each case of primary breast cancer is referred to the *x*-ray department for a complete cycle of treatment, and decision as to subsequent surgical intervention in doubtful or border-line cases reserved for a period of two to four weeks. Before treatment is begun, a careful radiographic examination of the chest is made to determine, as far as possible, the status of the pleura and mediastinum. The cycle of treatment follows a routine plan up to a certain point and is then varied to meet the peculiar needs of the individual case. In all cases the involved breast, pectoral, axillary, infraclavicular and supraclavicular regions on the same side are treated, as a routine. When the growth presents clinical evidence of being more malignant, a wider field is covered to take in the epigastric region, a wide skin area around the breast, the inner half or all of the opposite breast, and the opposite axilla and supraclavicular region. The numerous paths of lymphatic extension immediately beneath the skin call for a wide zone of skin radiation, especially in case of carcinoma "*en cuirasse*," in all bulby growths, and in those with retraction of skin. Ewing,[1b] has noted that in a certain percentage of cases there is a direct lymphatic connection with the opposite axillary nodes. Tumors of the inner segment of the breast are most favorably located for this, and in all of these the opposite axilla should receive particular at-

tention. Mandley's[1c] finding of approximately 12 per cent of cases at autopsy, showing abdominal involvement without chest invasion, indicates the need for radiation over the epigastric region. As stated before, the axillary trunks should always be radiated, because they are the main paths of dissemination; and since there are such free anastomoses between these and the subpectoral, infraclavicular and supraclavicular groups, radiation of one group should always be accompanied by exposures over all.

Once the areas to be treated have been determined, the skin over all available portals of entry is marked off into areas approximately 2½ to 3 inches square. In doing this it must be borne in mind that certain parts can be reached from more than one angle. Thus the breast itself can be radiated over its surface and from the side, the axilla can be reached both from before and behind as well as directly, and the same applies to the supraclavicular space. This radiation at cross-fire furnishes the most valuable feature of the treatment, because the absorption of radiation in the deeper parts, in its greatest intensity, is the object sought. The skin over each area treated receives its tolerance of radiation from the one direct dose; but this is not the case, of course, in the deeper tissues. Boggs[2] has shown that with an 8-inch skin-target distance the tissues 4 inches beneath the skin receive about one-seventh as much radiation as the skin. It is thus extremely important to utilize as much cross-firing of rays as possible.

Each area mapped out as indicated receives a massive dose of *x*-rays, in other words, as much as the skin will tolerate without superficial destruction. Our fixed factors in giving these exposures have been an 8-inch skin-target distance, 9½ inch parallel spark-gap back-up, 7 milliamperes of current through the tube, and usually 4 millimeters of aluminum filter. In some instances, where deeper penetration was desired, especially about the axilla, in an effort to obtain this, the filtration was increased to 6 mm. of aluminum. The equipment has been a high tension interrupterless transformer and Coolidge tube, throughout.

Treatments are given daily in an effort to cover the period as rapidly as possible. The number of exposures given each day varies, depending on the way in which the patient tolerates the treatment; usually two to four areas may be radiated at one sitting without an undue amount of nausea and depression. The immediate unpleasant symptoms incident to treatment are never severe enough to be classed as contra-indications to the procedure. To date, we have reached no definite conclusions as to the cause of this nausea of radiation. The mental factor plays a part, undoubtedly, but does not account for all of it. Our observations on the CO_2 content of the blood before and after treatment have given little information of value. Certainly the generation of gases about the transformer has little to do with it, else why should the operators and attendants be free from such symptoms at all time.

After the cycle of treatment is completed in this manner, the patient is placed under the observation of the surgeon and roentgen therapeutist. The cases belonging to the strictly operable class are operated upon two weeks after the *x*-ray cycle has been completed. Those more advanced are continued in the *x*-ray department and given another cycle of treatment at an interval of four weeks. After one or two cycles of treatment, a certain percentage of cases, inoperable at first, receive sufficient improvement to place them in the operable group.

Since the operation is not done until two weeks after the last *x*-ray treatment, it is at once apparent that the skin is ready for a cycle of postoperative *x*-ray immediately the patient is able to be out of bed following the radical operation. The cycle is carried out in exactly the same manner as the former cycle of preoperative radiation.

This procedure permits of doing the surgical removal of the breast in the interval between two cycles of *x*-ray treatment. It has no adverse influence on the healing of the surgical wound, and results in considerable advantage to the patient. A gain of at

least two weeks is made in the application of external radiation, and no time is lost in the follow-up of postoperative treatment. Our study of the material removed at operation after this preoperative treatment shows that the surgeon has a less malignant type of tumor to deal with; the neoplastic cells show marked degenerative changes, and the replacement of tumor tissue by fibrous tissue indicates a reparative process. The atrophy of lymphatic channels aids materially in blocking dissemination of the disease. Treatment into the open wound is obviated, and its ideal accomplished, in a more thorough manner at an earlier date. Many cases at first belonging to the inoperable class are rendered operable.

The routine of our postoperative treatment is to give each patient three complete cycles at intervals of a month, following essentially the course of the preoperative cycle. In some instances the knowledge gained at the time of operation and by microscopic study of the material suggests broadening the field of radiation. In most cases the postoperative radiation is not given as rapidly as the preoperative cycle, for the obvious reason of lessening nausea and vomiting.

After the third cycle of postoperative radiation has been completed, the patient is usually placed under observation for a prolonged period, and no further treatment given for four to six months, and then a fourth cycle administered as an added precaution. However, this varies with the individual case and in the extremely malignant types it is best to keep up the monthly cycles for some time after the three months' period.

BIBLIOGRAPHY

1. Ewing, J. Neoplastic Diseases. Philadelphia: W. B. Saunders Company, 1919. 1a, 521; 1b, 508; 1c, 510.
2. Boggs, Russell H. The Treatment of Malignancy by Combined Methods. *Am. J. Roentgenol.*, 1919. vi, 481. Treatment of Cancer of the Breast with Roentgen Rays. *Interstate M. J.*, 1918, xxv, 210.
3. Pfahler, G. E. The Breast. (Deaver & McFarland). Philadelphia: P. Blakiston's Son & Co., 1917. 3a, 650; 3b, 651; 3c, 653; 3d, 640; 3f, 645.
4. Todd, C. E. Surgical and X-Ray Treatment of Cancer of the Breast. *Med. J. Australia*, 1916, iii, 1-3.
5. Morton, R. Earlier Postoperative Raying of Breast Cancer. *Lancet*, 1917. No. 1, 427.
6. Holding, A. F. Treatment of Cancer by Physical Methods. *Am. J. Roentgenol.*, 1913-14, i, 368.
7. Knox, R. Radiography, X-Ray Therapeutics and Radium Therapy. 1919. 372.
8. Von Angerer, O. *Handb. d. prakt. Chir.*, 1913.
9. Bythell, W. J., and Barclay, A. E. X-Ray Diagnosis and Treatment. 1912. 128.
10. Newcomet, W. S. Radium and Radiotherapy. 1914. 241.
11. Archibald, C. H. Roentgenotherapy in Cancer; *Am. J. Roentgenol.*, 1914-15, i, 780. (Here abstracted, appeared originally in *N. York M. J.*, 1915, ci, 1157-1159.)
12. Ochsner and Percy. New Manual of Surgery. 1917. 214.

A CASE OF PEDUNCULATED ADENO-CARCINOMA OF THE STOMACH AND POSSIBLE ERRORS IN DIAGNOSIS

By EUGENE P. PENDERGRASS, M.D.

Assistant Roentgenologist in the University Hospital, and Instructor of Roentgenology, Post-Graduate Department of the University of Pennsylvania

AND

HENRY K. PANCOAST, M.D.

Professor of Roentgenology, University of Pennsylvania

PHILADELPHIA, PENNSYLVANIA

THE report of the following three cases was prompted by their roentgenologic similarity and the great possibility for error if proper attention is not given to our instructions in having the patients prepared for a gastro-intestinal study. In some cases only after a careful history and laboratory findings are we able to reach a conclusion. If the correct diagnosis is to be made, the roentgenologist, the surgeon and the clinician must cooperate.

CASE I. Male, aged thirty-one years. Admitted to the University Hospital November 12, 1919. C.C. Severe pain in upper abdomen. H.P.I. Admitted to Army Hospital May, 1918, on account of weakness. This weakness had taken two or three weeks to develop. His condition was diagnosed as pernicious anemia, and he was given five transfusions of 300 c.c. each. He was discharged from the hospital September 4, 1919. Very soon the patient noticed that he

FIG. 1. CASE I. ERECT EXPOSURE. Directly after the second opaque meal and six hours after the first meal, showing almost no contents in the intestinal tract.

FIG. 2. CASE I. NINETEEN HOURS AFTER PREVIOUS EXAMINATION, showing the amount of retention and the defect to perhaps better advantage.

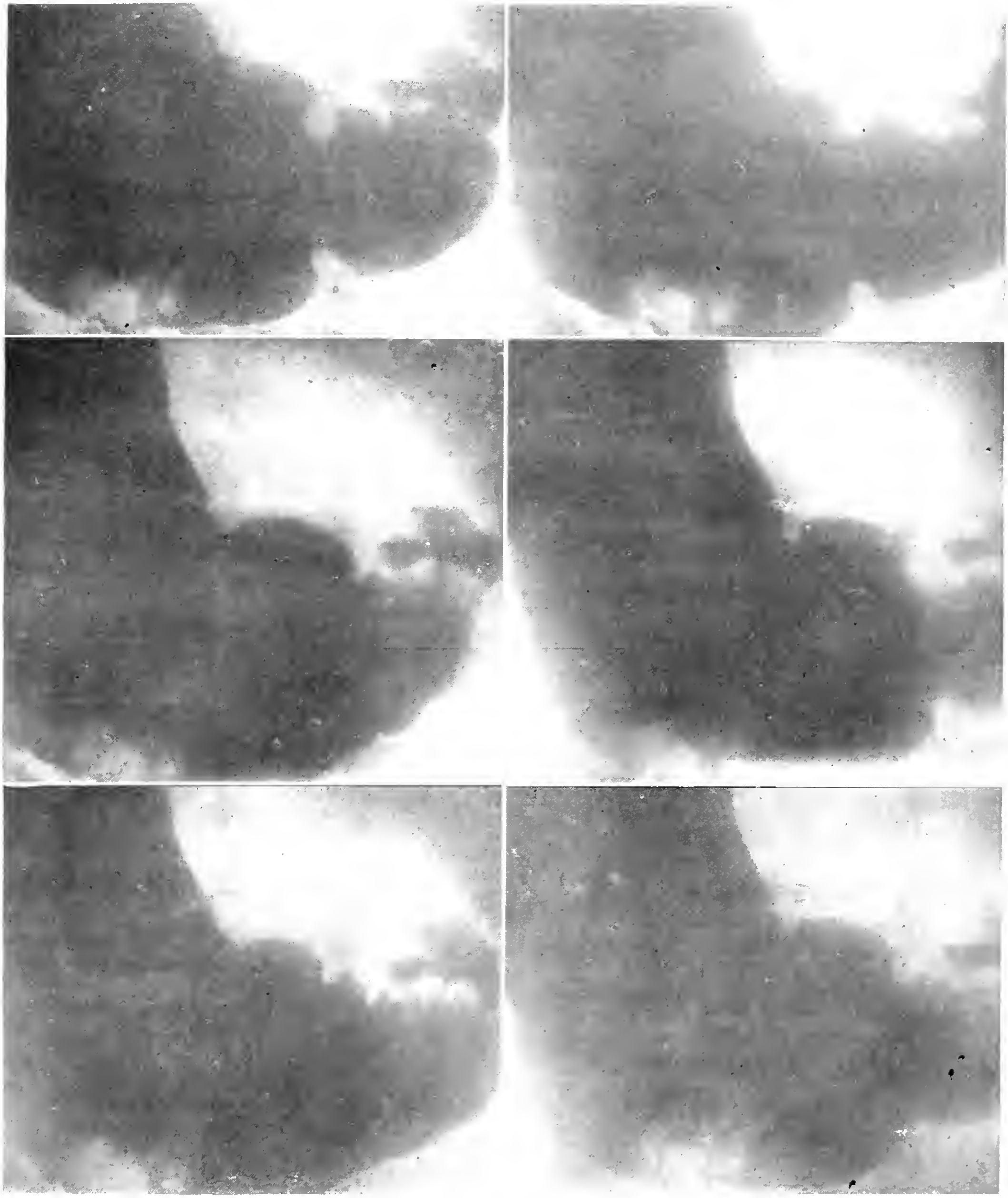


FIG. 3. CASE I. SERIAL EXPOSURES IN THE PRONE POSTURE. The defect is quite noticeable in the dependent portion of the greater curvature. This did not interfere with the peristalsis.

was losing his appetite and suffered from some pain and distension in the epigastrium. The pain, however, did not bear any relation to meals. His physician gave him morphia for the pain, and after taking the morphia he was constipated. The remainder of the history was negative.

PHYSICAL EXAMINATION. — *Abdomen:* Visible peristalsis in upper abdomen near the umbilicus. A mass was felt under the right costal margin about the size of a hen's egg. It was hard, slightly tender and moved with respiration. Gastric analysis: 90 c.c., white, normal odor. Total acidity 10; free hydro-

chloric acid, 0; no occult blood. Wassermann, negative. Feces, trace occult blood.

Roentgen Ray Findings. — *Stomach:* Moderate dilatation; obstruction, probably of duodenal origin; a permanent defect in the dependent portion of the greater curvature, probably papilloma or carcinoma, or even the possibility of a sarcoma. Peristalsis was quite marked throughout the examination. There were considerable opaque contents remaining in the stomach up to and beyond eighteen hours. The patient was not examined further than this. *Duodenum:* A constant filling defect strongly suggesting duodenal ulcer. *Colon:* Intestinal examination not carried out because of findings in the case of the stomach. The liver and spleen were found to be enlarged.

Fig. 4. Case II. Erect Posture after Second Meal and Six Hours after First, showing the irregular defect at the pyloric extremity.

Fig. 6. Case II. Erect Posture, Second Examination, showing no evidence of the defect previously noted.

Operative Findings.—Operation November 21st. Gastrotomy was performed over the growth, which measured 2 by 3 by 4 cm. and hung by a pedicle. It was removed because it only involved mucosa. Frozen sections showed the growth to be adeno-carcinoma. The gastrotomy opening was closed and a posterior gastro-enterostomy done. The defect in the duodenal cap was found to be due to adhesions to the liver at a point where there was a large nodular metastatic growth. There was no duodenal ulcer so far as could be ascertained, as the duodenum was not disturbed. The patient died December 12, 1919. (Figs. 1, 2, 3.)

Case II. Female, aged forty-five. Admitted to the University Hospital October 31, 1919. Discharged November 9, 1919. C. C. Nervousness and occasional attacks of indigestion. H.P.I. The attacks of indigestion dated back fifteen years ago when she had an acute attack, coming on two months after delivery. During the attacks, which came on at irregular intervals, she had severe pain in the epigastrium, radiating upward equally to the two shoulders and making her feel short of breath. Vomiting relieved these attacks, so she took hot water to bring on emesis. The bowels were moderately consti-

FIG. 5. CASE II. SERIAL EXPOSURES MADE IN THE PRONE POSTURE, showing the defect to better advantage but not showing extension.

pated always. There was never any jaundice. The remainder of the history was negative.

GASTRIC ANALYSIS.—White, normal odor. Trace of occult blood. Free hydrochloric acid, 6, 16, 28, 32, 20, 30, 20, 20, 20. Total acidity 26, 27, 45, 50, 40, 50 60, 40, 60.

ROENTGEN RAY FINDINGS.—*Stomach:* A moderate degree of ptosis. Slightly prolonged emptying time within six-hour period. A slight permanent defect, irregular in outline, at the pyloric extremity of the stomach found in every exposure in both erect and prone posture, suggesting a foreign body or a papilloma. The plates were

FIG. 7. CASE II. SERIAL EXPOSURES, SECOND EXAMINATION, showing no evidence of the defect.

examined by a number of visiting roentgenologists who concurred in this opinion. *Duodenum:* Negative. *Colon:* Ptosis of the right side and transverse colon. Decided stasis notwithstanding daily movements. Ileal stasis at the end of eighteen hours. The appendix was visualized, but there was no tenderness over it. Direct examination of the gall-bladder region showed three or four shadows which were very suggestive of gall-stones. (Figs. 4, 5.)

A second examination was requested to confirm the diagnosis of the gastric condition. It was made eleven weeks after the first

FIG. 8. CASE III. FIRST EXAMINATION, DIRECTLY AFTER SECOND MEAL, Erect posture, showing defect in pyloric and stomach.

FIG. 9. CASE III. SECOND EXAMINATION, showing no evidence of the defect previously noted.

and showed no evidence of the filling defect noted at the previous examination. (Figs. 6, 7.)

CASE III. Female, aged forty-nine. C.C. Localized pain and feeling of obstruction. A diagnosis of gastroptosis, another of ptosed kidney, and lastly a neurasthenia syndrome with gastro-intestinal symptoms. She was anemic.

ROENTGEN FINDINGS.—*Stomach:* A moderate degree of ptosis and a moderate retention after six hours. Slight pyloric spasm. A permanent defect in the shadow of the stomach near the pyloric extremity in every exposure in both erect and prone postures. In view of the possible seriousness of this appearance a second examination was advisable. It was made three and a half weeks later and showed no evidence whatever of the defect previously noted. The same degree of ptosis and the same slight pyloric spasm were found. *Duodenum:* Negative. *Colon:* Ptosis of the entire structure and a very marked colonic stasis. Appendix visualized, but there was no tenderness over it. (Figs. 8, 9.)

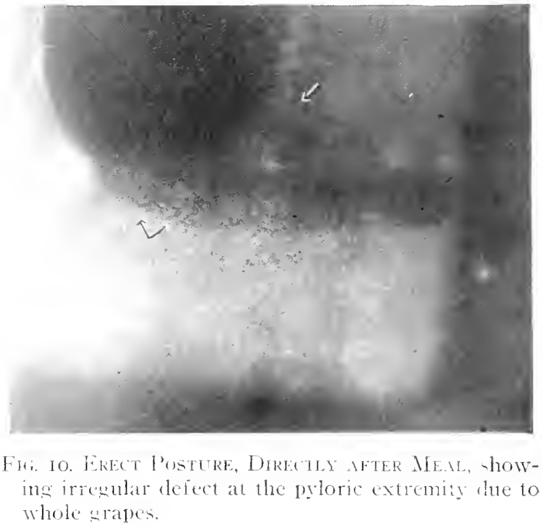


FIG. 10. ERECT POSTURE, DIRECTLY AFTER MEAL, showing irregular defect at the pyloric extremity due to whole grapes.

All patients were examined according to

the double meal technique. In trying to find what would cause the above filling defects, we tried giving a patient some grapes with his breakfast. On examining him six hours later no filling defect was found. A second patient was asked to swallow the pulp of an orange and was examined six hours later and no filling defect was found. A third patient was given grapes, some of which were swallowed whole. He was examined directly after his grape lunch and large filling defects were found. (Fig. 10.)

The primary findings in Cases II and III prove that such appearances cannot always be taken as positive evidence of an organic lesion. A second examination is recommended, so that the first diagnosis may be confirmed or disproved. Sufficient time, three weeks usually, should be allowed to intervene in order to prevent any injury to the skin that might come from repeated roentgen ray exposure.

NOTES ON THE ROENTGEN TREATMENT OF LEUKEMIA,*

WITH REPORT OF A CASE UNDER TREATMENT FOR FOUR YEARS

By W. O. UPSON, M.D.

BATTLE CREEK, MICHIGAN

In the treatment of leukemia the *x*-ray occupies a position of prominence, since this disease has proved especially amenable to radiation. If the patient is kept under observation and treatment renewed when recurrence occurs, he may maintain a reasonable degree of efficiency and be enabled to continue his work indefinitely.

Extensive experimentation has shown that those tissues of the body most responsive to the action of the *x*-ray are the blood, the spleen, the bone marrow and the lymph nodes. Leukemia has been termed a malignant disease of the blood, and the effect of the roentgen ray upon the blood and blood-forming organs would seem not incomparable to its effect upon the tissues of certain malignant growths. In normal animals subjected to radiation there is a noticeable destruction of the cells of the lymphoid tissue, spleen and bone marrow; but in addition there is, according to Capps and Smith, a production of leucolytic substances which have the power of destroying other leucocytes. These investigators discovered further that the serum of leukemic patients under *x*-ray treatment when injected into other leukemic patients caused a decided drop in the leucocyte count. On the other hand, the serum taken from patients before radiation had quite the opposite effect.

Melchener and Wolff in their experiments on the causation of leukemia found that healthy animals injected with the serum made from spleen which had been subjected to radiation, exhibited a marked reduction of the leucocytes; while an injection from spleen that had not been irradiated produced a leucocytosis. Thus it would seem that the benefit derived from radiation in leukemia is not alone due to a destructive action on the blood and blood-forming organs, but to certain leucolytic substances that are in some manner produced by the treatment.

The best results in the treatment of leukemia by the roentgen rays have been secured by first exposing the long bones to radiation, and later the spleen. With this method the reduction of the leucocytes is slow but more permanent. Following treatment of the long bones there will be found at least a moderate reduction in the size of the spleen. In some instances the spleen has been reduced to normal size by treatment to the

*Thesis presented with application for membership in The American Roentgen Ray Society, 1920.

long bones alone. When radiation is applied directly to the spleen there usually results a slight rise in the leucocyte count as well as some evidences of a toxemia. Less toxemia will result if only two or three small areas are treated each day; the leucocyte count will be reduced rapidly enough.

The applications should cover a period of ten to fourteen days, when, if the dosage has been sufficient, the leucocyte count should fall to near 20,000, and the spleen should be considerably reduced. The series should not be repeated under three to four weeks, and not then unless the size of the spleen and the blood count would indicate a recurrence. In many instances it has been found that two to four series a year have been sufficient to keep the patient in a fair state of health.

To illustrate the more flattering results that may be obtained, I wish to report one case which has been under observation and treatment for about four years at the Battle Creek Sanitarium.

Case No. 129543; male; American; white; age forty-nine; attorney. The patient had all the diseases of childhood, and had a mild malaria at intervals for twenty-five years. Six months previous to the time he came under observation in the *x*-ray department (July 6, 1916) the patient noticed that he became exhausted easily, that he felt tired and did not want to work, and had lost about fifteen pounds in weight. He had no gastric symptoms, but a certain distress in the abdomen due, he states, to the pressure caused by the enlarged spleen. The patient's attending physician made a diagnosis of splenic leukemia. He was put on large doses of arsenic for three months. When the patient arrived at the Battle Creek Sanitarium his blood count showed the white cells to be below 5,000, but in less than two weeks the white cell count had gone up to 142,500. Physical examination revealed a man with nutrition below par; skin of a bronze color with sallow mottling over the abdomen. The muscles were poorly nourished. The liver was enlarged, and the splenic dullness extended from the 5th interspace to the level of the umbilicus. Mucous membrane pale and skin reflexes sluggish.

TABLE I.

	Red Cells			*White Cells*	
Date	Hemoglobin	No. per c. m.	per cent	No. per c. m.	per cent
7/19/16	(Treatment was begun on this date)				
7/26/16	75	4,100,000	82	142,500	1,900
8/2/16	75	3,800,000	76	174,000	2,320
8/9/16	80	4,200,000	84	51,000	680
8/16/16	70	3,350,000	74	9,000	120
8/23/16	80	4,300,000	86	6,700	90
	(Treatment was discontinued on this date.)				
9/3/16	85	4,500,000	90	28,500	380
9/10/16	80	4,500,000	90	72,000	960
9/13/16	80	4,500,000	90	112,500	1,500
9/17/16	70	3,900,000	78	43,500	580
9/20/16	70	3,500,000	70	35,000	400
	(Treatment was again begun on this date)				
9/24/16	82	4,400,000	88	35,000	400
9/27/16	76	4,200,000	84	15,000	200
10/11/16	78	3,800,000	84	9,000	120
10/14/16	86	4,300,000	86	14,200	190

Treatment was begun by Dr. James T. Case in July, 1916. It consisted of 25 milliampere minutes at a 9-in air gap, with a focus-skin distance of 7 inches and 4 millimeters of aluminum and a piece of sole leather used as a filter. Treatment was first applied to the long bones and afterwards to the spleen by the cross-fire method, the total dosage for the series being as nearly as possible 150 x units measured underneath all

the filters. Kienbock pastilles were used for estimation of dosage. The second series was begun September 20th. Following this series of treatments the white blood count was almost normal; in fact the entire blood examination showed an almost normal condition. After this the patient returned home and for nearly a year there were no symptoms. The report of the attending physician on the condition of the patient at this time was: "He has made wonderful improvement generally. The spleen has receded to practically normal size. The blood is normal for a greater part of the time, but there is a tendency to leukocytosis at times."

In July of 1918 the patient again returned for treatment. Physical examination showed a very low state of nutrition, skin lemon tinted and patient apparently very anemic. He showed considerable edema, especially of the legs and face. The muscles were flabby and wasted. The pulse was 120. The spleen was markedly enlarged, extending from the 6th rib to below the costal margin.

Two series of treatments were given, treating the proximal ends of the long bones and the spleen. Fifteen x units were administered (23 milliampere minutes, focus-skin distance 7 inches, 5 milliameters of aluminum and sole leather filter). The physician's

TABLE II.

	Red Cells			*White Cells*	
Date	Hemoglobin	No. per c. m.	per cent	No. per c. m.	per cent
7/20/17	80	3,900,000	78	225,000	2,500
7/25/17	75	3,800,000	76	47,600	3,000
7/27/17	76	4,300,000	87	187,500	635
8/1/17	85	4,200,000	84	43,500	580
8/12/17	77	4,000,000	80	56,200	750
8/17/17	77	4,100,000	82	60,000	800
8/23/17	77	4,200,000	84	65,000	800

The accompanying table will show the blood changes during the three series of treatments in 1916. (See Table I.)

In July, 1917, the patient returned with a white cell count of 150,000 to 225,000. A third series of treatments was begun July 22, and a fourth August 14. After these two series the blood became practically normal, the white cell count being 13,000. The patient had gained in weight and strength and there was a great reduction in the size of the spleen.

The blood changes during the series of treatments in 1917 are shown in the accompanying table. (See Table II.)

report at the end of the treatment stated: "The patient reacted to his treatment very satisfactorily. At the time of his arrival his percentage of white cells was 1,900 and later 1,795, but at the time of his departure was down to 140 and had been as low as 100 per cent. His strength improved very materially and his red blood cells had increased from 2,500,000 to 3,400,000 and his hemoglobin from 48 to 60. The edema had entirely disappeared and his strength was very much better. The spleen was reduced to normal size."

Table III shows blood changes during treatment in 1918:

TABLE III.

	Red Cells			*White Cells*	
Date	Hemoglobin	No. per c. m.	per cent	No. per c. m.	per cent
7/4/18	48	2,500,000	50	142,500	1,900
7/18/18	50	3,200,000	64	102,000	1,360
7/25/18	60	2,600,000	52	75,700	1,010
7/31/18	55	3,200,000	64	130,100	1,735
8/1/18	55	3,100,000	62	134,600	1,795
8/7/18	55	3,000,000	60	69,700	930

The patient returned again for examination in April, 1919. Since his treatment in the previous year he had remained subjectively very well. His strength had been very good and he had been busily at work most of the time. However, a few weeks before returning here he noticed that his spleen had begun to enlarge and he thought it best to appear for a new examination. X-ray treatments were begun on May 1st, 1919, with the results which are here shown in Table IV.

TABLE IV.

	Red Cells		White Cells		
Date	Hemoglobin	No. per c. m.	per cent	No. per c. m.	per cent
5/4/19	60	2,500,000	50	91,800	1,225
5/8/19	40	3,200,000	64	145,000	1,940
5/11/19	50	3,000,000	60	105,850	1,400
5/27/19	55	3,500,000	70	94,000	1,310
	48	3,400,000	68	66,000	800
	52	3,500,000	70	54,000	730

The patient came back again February 12, 1920, for further treatment. After going home in September he continued to feel subjectively well and gained considerable weight. After about three months the spleen began to enlarge, and he noticed a loss of weight. In all he had fallen off 26 pounds since leaving here last time. His appetite had become poor, especially during the last month, and there had been a gradual diminution in strength. For the last two or three weeks he had not been sleeping so well. The bowels had become loose.

Physical Examination.—Nutrition below par. Skin rather lemon tinted. Muscles decidedly poor in nutrition. Skin dry and poorly nourished. Tongue clean. Sclera muddy and subicteric. Pulse rapid, regular. Heart somewhat enlarged downward and to the left; valves negative. Breath sounds rather increased in intensity posteriorly. Spleen enormously enlarged, extending from the eighth rib to three inches below the umbilicus and two and a half inches to the right of the umbilicus. Liver enlarged, extending from the fifth interspace to below the costal margin. Kidneys not palpable. No marked abdominal tenderness. Skin reflexes sluggish. Knee jerks decidedly sluggish. Weight about 130 pounds.

One series of treatments was given, paying special attention to the proximal ends of the long bones, after which the spleen was treated by the usual cross-fire method. When the treatment was started the white blood count was 206,200. A few days after the series was completed the last blood count was taken, which showed a white count of 67,000. The spleen had materially decreased in size, but not to normal. The patient's general condition had decidedly improved and he had gained several pounds in weight.

SUMMARY.

1. It would seem that the benefit derived from radiation in leukemia is due not alone to the destructive action on the blood and blood-forming organs, but to certain leucolytic substances that are in some manner produced by the treatment.

2. By applying the treatment to the long bones first, there is a more gradual but more lasting reduction of the leucocytes with less toxic effect than when the treatment is applied to the spleen first.

3. During the course of the *x*-ray treatment there is usually noted a slight initial rise of the leucocytes, followed by a gradual reduction of the white count, with an increase of the red cells.

4. It is observed that leukemia usually does not respond so readily to treatment after the first or second series.

RADIUM ELEMENT VERSUS EMANATION*

By ALBERT SOILAND, M.D., F.A.C.P.

LOS ANGELES, CALIFORNIA

THIS argument will be based upon the writer's personal knowledge of the use of radium element and upon his observation of the radium emanation method in the hands of well known radiologists. It is admittedly difficult to be wholly impartial when one essays a comparison between two methods that are expected to reach the same result, if he is trained to the use of one of these only. Nevertheless, absolute fairness, to the extent of the writer's ability to observe it, will prevail, and it is hoped that a free and frank discussion of the relative merits of the two methods will follow.

From time to time certain remarks will reach the ear of the radium worker with element, that he is out of date, that only with emanation needles can really scientific work be effected. While such remarks are irrelevant and will perhaps not concern us greatly, yet when our patients inquire of us as to the correctness of such rumors, they take on a more serious aspect, particularly for those among us who are working with limited amounts of radium element. It is to be hoped that no one associated with our scientific societies will permit such insinuations to pass by unchallenged.

A comparison of the use of element with that of emanation can be made from two angles, the financial and the clinical. It is principally the latter that we shall deal with here. The financial side of the question offers slight ground for debate. One either can, or cannot, afford to invest a sum of money sufficiently large to cover a complete emanation station. If one is more or less limited in his finances and has to bear the burden of expense alone, his investment in radium will more than likely be considerably under one gram of this precious mineral, and this will be in one of the insoluble salts. If money is plentiful, or an endowment available, the result will of course be one gram or more of radium in solution. From a standpoint of gross utility alone, one has no business with so large an amount of radium in any other form than solution. Radium in quantities less than a gram does not lend itself readily for emanation purposes. It is then best applied in the various forms of tubes, needles and plaques, now so conveniently arranged by the manufacturers with accessory appliances for therapeutic use.

From the clinical side, both radium element and radium emanation have their quota of supporters, some of whom claim specific virtues for their favorite method. It is assumed that all accept as a basic fact the cardinal point that it makes no difference in the final result of every radium treatment, whether element or emanation is used, provided the duration of the period of radioactive units is the same during the exposure.

There are three distinct advantages with emanation, namely: the ability to make fractional dose units easily; the convenience of imbedding such units into tumor tissue; and the great fact that the parent radium is always safely ensconced in a protected sealed chamber, free from all kinds of molestation. The latter is the main point of advantage; for no matter whether a single emanation needle or any number of these are lost, either in the tissues or elsewhere, the operator knows that no serious results will follow, owing to the limited time of radio-activity possessed by the radium gas. Of importance, also, is the fact that no particular monetary loss has been occasioned. Upon merely a brief analysis the three named points of apparent superiority seem quite insurmountable to the advocate of the element method. A little closer inspection, however, shows that they are not so formidable. True, the fact that one can lose or destroy the emana-

* Read before the Pacific Section of THE AMERICAN ROENTGEN RAY SOCIETY, Catalina Island, California, June 17-19, 1920.

tion needle without feeling the loss of the parent radium, is of itself one great dominating factor that cannot be contradicted in any way. But in regard to the first two points of superiority claimed for the emanation method, the advantage is not so marked, although the use of radium element is, in these respects, somewhat less convenient. In the face of the foregoing admissions, what can the advocate of radium element offer for his method? If he is of the proper caliber, he will probably concede that he is using element largely because he is unable to command an emanation plant.

However, from the standpoint of applied therapy, there are certain advantages in using the elemental form of radium. In the first place, it is considerably easier to employ. Again, the calculation of an ever changing and depreciating millicurie standard is avoided. Third, the milligram unit of activity in radium element being constant and stable, permits of a simplified and more accurate dosage at all times. The additional fact that one is compelled to watch more closely the implanted element tube or imbedded element needle, calls for even greater care in the supervision of the patients so treated. This point is worthy of reflection.

What is the minimum amount of radium with which one can attempt comprehensive radium therapy? This question is not easily answered, much depending upon the number of patients treated during the same period. The writer will venture the statement that not less than 100 milligrams can be considered. It has happened that physicians with radium in their possession, in amount not exceeding 25 milligrams, have made known by means of printed announcements sent to the profession that they were prepared to handle referred radium work. Such instances are happily rare, but if encouraged will surely lower standards in a way similar to that done by *x*-ray operators of a former day, who with inferior apparatus and extremely limited knowledge attempted all sorts of impossible diagnoses and treatments, and thus brought about a state of affairs that even in this day of highly specialized apparatus and modern technique we are yet stigmatized for.

Radium therapy, whether by element or emanation, has now fully weathered the experimental stage. A number of influential medical men still look upon it with disfavor; but careful and conscientious work, as exemplified by that of our radiological societies, has amply demonstrated the increasing scope of its usefulness. It matters nothing to the patient whether radium element or radium emanation is used in his individual case, pro-

ELEMENT	EMANATION
Is available in small amounts.	Requires an investment of $100,000 or over.
Can be used quite extensively and with an investment from $20,000 to $50,000.	Sealed in vault, requires no insurance, but expense for quarters greater and cost of skilled help increases overhead expenses.
Requires less space for operation, but requires a 2 per cent insurance carriage.	Loss of emanation needles of no monetary significance and limited radiation period makes loss in tissues immaterial.
Tubes, needles and plaques bearing parent radium must be carefully protected from loss in tissues to avoid over action.	Has a distinct time limit of activity and a varying loss of its energy until spent.
Has unvarying output of energy of ratiotion.	Can be made up in any form desirable to suit each individual case. A distinct advantage.
Can be obtained in suitable form of applicators to meet any requirements.	Technique is more complicated.
Dosage easily computed.	Results not so readily duplicated, owing to more work necessary to match applicators.
Technique easily acquired.	
Results readily duplicated.	

Results: R element and R emanation exactly alike if equal energy of radiation is used.

vided he gets results; and, in the final analysis, that which does the work is the sum total of the energy of radiation.

Therefore, let us continue the study and scientific application of the material we have in hand, confident in the knowledge that radium has done more to assist surgery and the roentgen ray in combating malignancy than any other therapeutic agent known at the present time.

SPRING-CLIP FOR HOLDING X-RAY FILMS ON THE ILLUMINATION BOX

By GEORGE E. PFAHLER, M.D.

PHILADELPHIA, PENNSYLVANIA

IN the transition from plates to films in roentgenographic work, much difficulty has been encountered in holding the films in a satisfactory position on the illumination box, and I have seen nothing on the market that accomplishes this effectively.

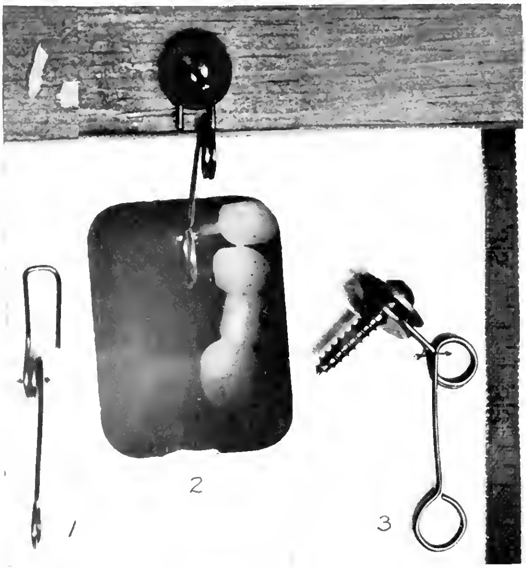


Fig. 1. Shows Clip in Reverse Position so as to demonstrate the hairpin curve to which the screw and washer are attached.

Fig. 2. Shows the Clip Holding a Dental Film. It will hold a 14 x 17 equally well.

Fig. 3. Shows a Lateral View of the Spring Clip beside a Tape Measure, giving relative dimensions.

With the aid of my mechanic a successful spring-clip has been developed to be attached to the upper border of the illumination box at intervals of four inches. The clip is made of spring wire No. 17 gauge, bent in the shape shown in the illustration. The spring-clip measures 1¼ inches from its shank to the circle, and 1¼ inches from the circle to the lower curve. This size will vary somewhat with the depth of the glass from the frame of the illumination box. The spring is attached to the wood at the top of the illumination space by means of a screw and washer. When these clips are connected one can simply push the film under the clip without even touching the clip, and there is sufficient tension on the spring to hold the film in place. It eliminates any curling or movement of the film while marking or writing on it, and when it is ready for removal one only needs to take hold of it and pull it out. With reasonable care there is no scratching of the film. The springs will have to be modified somewhat according to the depth of the glass from the surface of the wood; but this can probably all be accomplished merely by increasing or decreasing the tension of the spring, and aside from this there is nothing to do except put the screws in place and attach the spring. It is inexpensive and efficient.

This spring-clip has been admired by roentgenologists and others who have visited my office during the past year, and I have therefore concluded that it would probably be of general interest to roentgenologists.

THE AMERICAN JOURNAL OF ROENTGENOLOGY

PUBLISHED BY PAUL B. HOEBER, NEW YORK CITY

Issued Monthly. Subscription, $6.00 per year. Advertising rates submitted on application. Editorial office, 480 Park Av., New York. Office of publication, 67-69 East 59th St., New York.

ANNUAL MEETING EASTERN SECTION

The Second Annual Meeting of the Eastern Section of The American Roentgen Ray Society will be held in Atlantic City at Haddon Hall-Chalfonte, on Friday evening and Saturday, Jan. 28, 29, 1921. Make hotel reservations early, mentioning American Roentgen Ray Society.

Communications regarding the program should be addressed to Dr. David R. Bowen, 82 West LaCrosse Ave., Lansdowne, Pennsylvania.

In all other matters concerning this meeting, address Dr. Joseph M. Steiner, 103 Park Ave., New York City.

ANNUAL MEETING CENTRAL SECTION A. R. R. S.

The Second Annual Meeting of the Central Section of THE AMERICAN ROENTGEN RAY SOCIETY will be held on February 21, 1921, at St. Louis, Missouri. Announcement of headquarters will be made later.

Communications regarding the program should be addressed to the president, Dr. James G. Van Zwaluwenburg, Ann Arbor, Michigan. The chairman of the local committee, Dr. Edwin C. Ernst, 412 Humbolt Building, St. Louis, may be addressed concerning matters of arrangements.

ADVANTAGES OF GROUP MEDICINE TO ROENTGENOLOGISTS

THE one big advantage to any specialty by inclusion in a large group clinic is in the establishment of values. It is not essential that original work be produced by the specialty represented in such a clinic; rather would one hope that the representing specialist will be interested in demonstrating the routine values of a diagnostic procedure or treatment upon a percentage basis.

The isolated specialist is able to produce original ideas, and he may accomplish results in a long list of successful cases which would seem to establish his method. Nevertheless, if this original idea is taken up, thoroughly analyzed, mercilessly debated by a staff, and routinely applied in an unprejudiced manner over a period of time upon a large number of patients, the true values will eventually be demonstrated in a much shorter space of time than if the majority of the profession was apprised of the method or idea through the literature and it was applied in an indifferent manner upon a few cases over a long space of time.

There are several brilliant groups devoted to clinical medicine and surgery in America. There are several hospital staffs which apparently cooperate as a group of specialists. It is interesting to observe that where the roentgenologist of such a group or hospital is a physician of sound judgment of a cooperative disposition, that roentgenology has gained values which have increased the usefulness of the specialty throughout the world.

It is not necessary to cite examples, but it is interesting. One does not need to state the name or the place in citing examples, but anyone familiar with the literature of roentgenology will not find it difficult to place the honors.

The idea of direct duodenal diagnosis originated in an efficient isolated roentgenologist's brain who proved his point to the satisfaction of other roentgenologists long before this method of duodenal diagnosis was comprehended by the general profession. It was proven to the satisfaction of the entire profession through its routine use in a large clinic where its percentage values were under the constant scrutiny of operating surgeon and examining clinician.

The idea of radiographing the sella turcica has not been new since the earlier years of our specialty, but the values were not conclusively demonstrated until the method was routinely used in a large clinic where this class of case was seen daily so that a mass of data was evolved that established values.

The idea of treating enlarged thymus by means of radiotherapy was sporadically applied throughout the world; but it remained for one clinic to analyze or treat or both analyze and treat every case of mediastinal enlargement in babies or children and demonstrate the effectiveness of such treatment to a majority of the profession.

At the present time there are several problems in roentgenology that have not been clearly demonstrated to the entire profession, and neither have they been routinely applied in several large clinics—gall-bladder roentgenology, appendiceal roentgenology, mastoid roentgenology. Each of these subjects has a splendid literature and every roentgenologist probably has his own ideas as to the inherent values of each; but there has never been any routine group analysis of their roentgen values upon a percentage basis with a cold calculating estimation of their importance in the completed case history. An unbroken tabulation of 5,000 cases as these cases come to a clinic is necessary; a similar unbroken tabulation by a single roentgenologist would not do—the latter would only have those cases whose symptoms prompted a roentgen examination.

There is another advantage to group clinic efforts; they furnish a reliable school of instruction in a specialty. Such clinics can demand that those applying for instruction in a specialty shall devote ample time really to digest the rudiments and gain a vision of the future possibilities and think in their chosen field. Such graduated instruction can also demand that the specialist accept contemporary instruction in other fields of medicine, so that his viewpoint will not be cramped and confined within the limits of one specialty. The student will always be served with the glowing example of cooperation that is constantly about, and he will learn to grasp his subject all the more firmly through the constant discussions and dissensions among the leaders of the group. He will be constantly establishing his values.

There is one disadvantage of the group system, and this should be considered by anyone who is contemplating allying himself thusly for the practice of medicine. Groups stifle individuality. Groups will never originate a genius. Groups attach individuals to themselves and engage the services of geniuses to their advantage and sometimes to the pecuniary advantage of the genius. Advancement in any branch of science, invention and knowledge depend upon the hypothetical vision of enthusiasts and dreamers. This is not for the group worker, for he must constantly apply himself to establishment of the values to group practice

of the visionary or enthusiastic problems of the isolated worker. The scrutiny of the group clips the wings of romaqntic scientific flight and forces reactionary conservatism.

Fortunately the practice of medicine or any of its specialties does not alter the disposition or the mental bent of the man, and therefore there will always be available physicians for group practice and for isolated practice. They are both necessary. One serves as a check upon the other. The disposition is the determining factor. Character, integrity and knowledge of his specialty are the common possession of each type.

E. H. S.

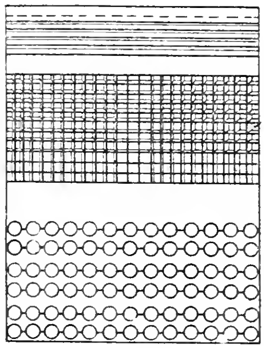
COMMUNICATION

To the Editor of The American Journal of Roentgenology:

In the June, 1920, issue of the Journal is an interesting article by Potter on the Bucky diaphragm principle applied to roentgenography. He described a simple, uniplanar grid which is mounted on bearings, made to run on a curved track with a very ingenious device for the control of the roller movement. Bucky in his description and in his work utilized the grid in a manner somewhat similar, but neither so ingeniously nor so practically as does Potter. I know that Bucky had used this simplified screen of parallel plates without cross members, though he found it less effacious than the "honeycomb." I have also had occasion to see some of the experimental work of Potter and am certain the apparatus he has evolved is of great value for the obtaining of a finer definition in the radiograph of deep structures.

There exists so much confusion regarding the nature of the Bucky diaphragm and its method of application that I am tempted to utilize your valuable space for a review of Bucky's work.

The prevention of the fogging of the recording surface by secondary and scattered radiations has been an ever recurring problem of roentgenology, and the nearest approach to any method for their radical removal has been made by Bucky in 1913. According to his invention there is placed between the sensitive plate or screen and the body a grid of interlaced strips of metal, making a sort of screen of many chambers, not unlike in structure to a honeycomb. The walls of these chambers are so arranged that they are parallel to the direction of the primary rays and do not obstruct their passage.



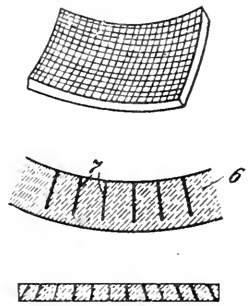


Fig. 1. In the upper part of the figure there are shown parallel and unidirectional walls, forming the ducts or chambers of the grid. In the middle, part of a grid is shown which consists of walls intersecting each other rectangularly, so that individual ducts or chambers of rectangular cross section will result. In the lower part a construction of the ducts of chambers of the grid is shown, whereby cylindrically bent metal sheets are used for making the chambers or ducts of the grid, the metal sheets being connected with each other by short connecting bridges, as indicated in the drawing.

Fig. 2. In the upper part of the figure is shown a grid having the shape of a section of the shell of a cylinder. In this form, because of being able to obtain radially directed walls the chambers may be made very narrow and the grid itself thin. In the middle part of the figure is shown a cross section of such a curved grid, with parallel plates without cross members. In the lower part of the figure is shown the cross section of a flat grid, which has been made from the grid represented in the middle figure by planing down until two flat, parallel surfaces are obtained.

The material of this grid is usually such a substance as completely absorbs the rays. The function of the grid is to absorb the scattered rays emerging from the body before these reach the recording surface.

Bucky states that the grid can be of plain or spherical form, and that the grid may be suitably mounted, provided with a contriv-

ance for imparting to it either linear, oscillating, circular, elliptical or any similar motion, so that the shadows which are cast by the grid will not affect the roentgen image of the part radiographed. He also suggests a device for accurately adjusting the tube upon the center of the grid, the distance corresponding to the inclination of the walls of the chambers and the position of the anticathode such as to be at the point of intersection of the planes of the walls of the grid. The device for imparting motion to the grid is such that each point of the grid will describe a circular path, the diameter of the circle of motion being equal to the length of the side of the smallest square of the grid. The velocity of the drive, he points out, must be such that the walls of the grid will not cast a visible shadow on the plate or screen. He suggests that the motive power may be furnished by a hand-crank, a clock fork or a motor.

Bucky suggests that a simple way of making a grid is to take a piece of celluloid (½ to ¾ in. thick) in which parallel cuts are made, one fourth, one sixth or one eighth of an inch apart. These cuts are filled in with lead salts bound in a proper medium. The plate may now be given a cylindrical shape or further modified as shown in Figure 2. It is thus apparent that Bucky has amply described all the possible variations of this "filter" which will undoubtedly prove a very valuable radiographic and fluoroscopic accessory.

I. Seth Hirsch,
11 East 68th Street,
New York City.

TRANSLATIONS & ABSTRACTS

Cofield, Robert B. Some Difficulties in the Diagnosis of Osteosarcoma. (*J. Am. M. Assn.*, Vol. lxxv, No. 19.)

Medullary type is more infusing than the periosteal, and that involving the short bones and vertebrae more difficult of diagnosis than when long bones are involved. He says the following concerning the roentgen ray examination:

While the roentgenogram is one of the most important adjuncts in differentiating bone diseases, it is often impossible to make a diagnosis, by the roentgen ray alone, in the early or atypical cases of osteosarcoma. It may necessitate serial examinations as well as a careful study of the full clinical data, and occasionally an exploratory incision to be positive of the true nature of the disease.

The roentgen ray picture of central sarcoma of the long bones is one of irregular destruction, with little or no tendency toward new bone formation until the periosteum is involved or broken through. The lesion is usually confined to one area, although multiple lesions are occasionally observed. Medullary sarcoma in the beginning may be confused with myeloma, cyst and osteomyelitis. Since they frequently have the same point of origin and are more or less destructive in character, it may require repeated roentgen ray examinations to differentiate these conditions. In myeloma, the globular outline of the tumor is maintained during its expansion; the swelling shows little or no tendency to extend along the shaft or break through its capsule and invade the surrounding tissues and, when completely removed, does not recur or produce metastasis; myeloma was formerly classified as a nonmalignant giant cell sarcoma, and is probably the same condition as described by Barrie under the title "chronic hemorrhagic osteomyelitis." In cysts, the cell wall is usually sharply outlined and clearly defined, and shows no tendency toward rapid expansion and invasion.

In suppurative osteomyelitis the roentgen ray findings are often not definite enough in the beginning to make a diagnosis; but as the disease progresses, the inflammatory redness of the skin appearing over the rapidly growing tumor would suggest a pus infection rather than malignancy.

Sarcoma involving the spine may portray an expansive tumor of the vertebrae simulating a circumscribed abscess when viewed in the anteroposterior position; and at the same time a lateral view may reveal the crushing of the vertebral bodies, as seen in Pott's disease. In other cases the extensive destruction of the vertebrae, accompanied by more or less hyperplasia of bone, may resemble syphilitic spondylitis. The severe pain, which is not relieved by fixation, the rapid invasion of the surrounding tissues and the early involvement of the spinal cord, with a resulting paraplegia, strongly suggest malignancy.

The roentgen ray picture of periosteal sarcoma is more distinctive in character, the new bone formation showing a trabeculation or spiculation at right angles with the shaft of the bone and presenting a smoky appearance. Early in its court it may be mistaken for osteoma, osteochondroma and myositis ossificans. Osteoma and exostoses are readily recognized, as they are conical or pedunculated, and their sharp outline is continuous with the bone from which they arise. Osteochondroma, when growing from the epiphysis laterally, gives a rather typical appearance; when of central origin it is more confusing. Either form may at any time take on the characteristics of malignancy, indicated by rapid growth and destruction of the enveloping capsule.

Myositis ossificans and ossifying hematoma, the latter occurring in subperiosteal hemorrhage from injury or scurvy, show a definite bony border due to the deposit of calcium salts, and the bone is laid down parallel to the shaft rather than perpendicular, as seen in periosteal sarcoma.

The diagnosis is most difficult when a rapidly growing periosteal sarcoma invades the adjacent joint; as the disease spreads to the joint capsule and periarticular tissues, the joint takes on a fusiform shape and symptoms

simulating a tuberculous, syphilitic or hemophilic lesion, the latter particularly when blood is aspirated from the joint.

Carcinoma of the osseous system is rarely confused with sarcoma, since carcinoma is of metastatic origin and always secondary to cancer elsewhere in the body; when occurring in bone, it usually attacks the cancellous tissue first and shows areas of regeneration along with the destructive process. I have seen a pathologic fracture of the femur heal under the influence of mechanical fixation only to break down again after the support was removed.

COLLIN, E. Radiotherapy in Sweden. (*Hospitalstidende, Copenhagen*, Aug. 25, 1920, Vol. lxiii, No. 34, p. 521.)

Collin says that the history of radiotherapy in Sweden is the history of one man, Prof. G. Forssel, of the chair of medical radiology at Stockholm. Since 1911, when the Radium Home was founded, the annual number of applicants for treatment has increased from 332 to 1,541. The results with inoperable cancer, he says, have been such that they "not only justify further research but they make the application and development of radium treatment of cancer a bounden duty." Collin's review of the technic and results concludes with the statement that what has been accomplished there with radium is far ahead of what has been realized in Denmark, while the achievements with roentgen irradiation are about the same in the two countries, but Denmark is far ahead in the matter of light treatment. Forssel insists that no one man can master both roentgen diagnosis and roentgen treatment. He reports 28 per cent of the cases of uterine cancer cured after a five year interval; the surgeons count only on 18 per cent cured of the operable cases after the same interval. The cancers treated included 94 per cent inoperable cases.

MEDICO-LEGAL. Circumstantial Authentication of Roentgenogram—Admissible Evidence When Roentgenogram is Lost. (*Quinn v. Flesher W. Va.*, 102 S. E. R. 300. *J. Am. M. Assn.*, Vol. lxxv, No. 2.)

The Supreme Court of Appeals of West Virginia says that, in this personal injury case, the roentgenologist, who made a roentgenogram of the plaintiff's injured hip, and another physician examined the plate after it was developed, and determined from the information received from the plate and from an examination of the injured leg that there was a fracture of the hip bone. After that the plate was mislaid, and it could not be found at the time of the trial, although thorough search was made for it. Still these physicians were permitted to testify that it disclosed a fractured hip bone. The defendants contended that this was error, first, because it was not shown that the roentgenogram was so taken as to represent correctly the object sought to be photographed; and, secondly, because the roentgenogram itself being secondary evidence and it being lost, no testimony could be offered based on a view of it. But the court holds that there was no error in either respect.

It is quite true that before a roentgenogram can be used as evidence it must appear that it was so taken as to represent correctly the object reproduced. Of course, it is not meant by this that some one must testify that it is in fact a correct representation. Manifestly, this would be impossible for the reason that the object thus photographed is not visible except with the aid of the roentgen ray machine. What is meant is that it must appear that the machine was so placed as to reproduce correctly the object brought within the radius of its activity. Nor need this necessarily appear by a direct statement of the operator to this effect, although it may be, and ordinarily is, shown in that way. It may, however, as well be shown from a detail of the circumstances. In this case the physician who took the roentgenogram was shown to be an expert with large experience in this work. The picture was taken with a view of determining the nature and extent of the plaintiff's injury with a view to treating it, and treatment was administered for the relief of the injury which the roentgenogram disclosed, with favorable results. This might not prove absolutely that the plaintiff was injured as disclosed by the roentgenogram, but the fact that the injury sustained by her responded to the treatment ordinarily administered for the relief of an injury such as that shown by the roentgenogram was, to say the least, very strong evidence that her injury was of that character, and sufficiently

authenticated the roentgenogram to justify its admission in evidence.

Was it proper for the two physicians who examined this roentgenogram to testify as to what it indicated? It seems to be very generally held that, where the original of a document is lost, a copy made from a copy may be introduced in evidence on a showing of the correctness of the first copy and the loss thereof. It is the best evidence obtainable. In this case, if we treat the roentgenogram as but a copy of the then existing condition, we have the original, which was the condition of the bone at the time, lost by a change in the conditions due to a lapse of time and the treatment administered, the only reproduction of that condition is lost, and the best evidence obtainable as to what condition actually existed at that time is the impression made on the minds of the two physicians from their examination of the plaintiff's hip and the roentgenogram thereof. It was not error to admit this evidence.

Furthermore, the court holds that where, after the trial of an action to recover damages for injuries sustained from a broken bone has been entered on, the defendant requests that a roentgenogram be made of the injured member, and the plaintiff is willing that it should be done, it is not error for the court to refuse such request where no reason is given for not having made the same before the trial, and it does not appear how long the trial will be delayed by granting such request.

Bensaude, R., and Rivet, L. Syphilis of the Stomach. (*Presse Médicale*, Paris, Oct. 18, 1919, Vol. 27, No. 60; cited *J. Am. M. Assn.*, Vol. 73, No. 23, Dec. 6, 1919.)

Bensaude and Rivet review the manifold forms in which syphilis may manifest itself in the stomach, describing with the roentgenologic findings a number of typical cases. There are no pathognomonic symptoms, but when everything else can be excluded, syphilis can generally be accepted, as also when there is multiple localization, as in esophagus and stomach, or the skiagram is unusual. A vigorous course of arsenical treatment improves the general condition whatever the cause, as a rule, but in syphilis the local lesion shows marked improvement besides. By this twofold effect they were able to differentiate and cure the syphilis in ten recent cases. This drug test is most instructive when it has been preceded by failure of dieting and the other ordinary measures for treating stomach derangement. Iodin and mercury by the mouth are usually well borne in case of gastric syphilis, while lesions of other kinds are aggravated by them. Stenosis once installed is scarcely amenable to any medical treatment, but before this stage is reached there is no pathologic condition which yields such brilliant therapeutic successes as gastric syphilis.

McKennan. Roentgen Ray Findings in Epilepsy. (*Archives of Neurology and Psychiatry*, September, 1920, iv, No. 3.)

Ninety cases were examined by McKennan. The results of the roentgen ray findings were: Tumors or evidence of pressure in the interpituitary area, 9 cases; bony deposits, 52 cases; small area, 10 cases; calcereous degeneration 2 cases; cerebropathy (this is not shown by the roentgen ray), 9 cases; no changes, 8 cases. total, 90 cases. Twenty-four cases occurred in persons over thirty-five years of age. More than 50 per cent of these cases being known to be due to an organic affection of the gland, causing it to be inefficient, would be a strong argument in itself for the conclusion that the other cases must have inefficient pituitary glands for some cause or causes. In some cases in which there was evidence of pressure in the pituitary area, McKennan has been able to have a roentgenogram made again in one or more years and has, in some instances, found that there was no progression. It would seem that if these cases are struma or other tumor growths the process of enlargement had ceased. It is possible that some of them may be simple hypertrophy. The question of pituitary feeding in epileptics, in the author's opinion, is an important one. McKennan has found that the extract of the whole pituitary gland in 2 grain doses, three times a day, and given four hours after eating, is the most satisfactory treatment. Bromids should always be used in conjunction with the pituitary extract. He is in the habit of using from 45 to 60 grains of bromid daily. After one year less bromid can be used, but the pituitary feeding must be kept up indefinitely, probably during the life of the patient.

Cordier, Victor. Radiotherapy of the Malarial Spleen. (*Bulletins et Mémoires de la Société Médicale des Hôpitaux de Paris.* March 11, 1920. Page 345.)

Cordier began this work during the war, and was induced to try radiotherapy for three reasons:

(1) The necessity of obtaining a rapid and definite relief in the secondary manifestations of malaria.

(2) The need of a method to control the painful splenomegaly.

(3) The impossibility of treating with quinine those patients with malarial hemoglobinuria.

He was successful in nineteen of twenty-one cases, securing reduction in the size of the spleen, disappearance of the pain, the paroxysms, the anemia and the cachexia. These were cases which had resisted all previous treatment.

The technic used was: Three treatments, at two-day intervals, giving a dose of eight units (Bordier) with a filtration of 3 mm. of aluminum. This series was repeated every three weeks. Three series were usually required. The paroxysms returned in from three to seven months in five cases.

The red cells were increased by from 500,000 to 1,000,000 in 70 per cent of the cases; the hemoglobin percentage was increased accordingly. The white cells were not affected. The parasites were found with some difficulty during the paroxysms, they could not be found in the intervals.

His conclusions are: In radiotherapy is a method requiring some time, difficult, and in some hands, dangerous. It does not totally destroy the parasite. In rebellious cases, especially where quinine is not tolerated, it is of great service if employed skilfully.

L. S. Goin, M.D.

Crosbie, Arthur H. Diagnosis and Treatment of Tuberculosis of the Genito-Urinary Tract. (*Boston Medical & Surgical Journal,* July 29, 1920, clxxxiii, 134.)

There is nothing particularly new to bring forward in this paper. However, a résumé of the means we have to-day to arrive at an accurate diagnosis can do no harm, especially as one still sees occasionally a surgeon who when he finds acid fast bacilli in the bladder urine is content to remove the kidney on the side where he can feel a mass without further study. I know of one case where this was done and the enlarged kidney proved to be a normal hypertrophied kidney and the dead kidney was left with fatal results.

The importance of radiographs in the diagnosis of renal tuberculosis is coming more and more to be felt. To be sure, in many cases the radiograms are negative, but where there is much caseation, as where there are large abscesses filled with cheesey material, one is very apt to get suggestive shadows. I have recently seen a case where the *x*-ray helped a great deal. This was one where there were a few shadows in the cortex of the kidney which resembled stones. This represents a form of renal tuberculosis where the disease is far removed from the pelvis and where the bladder symptoms were slight and the urine negative, except for a few pus cells. I have known of two similar cases in the past where the radiographs showed shadows in the cortex resembling stones. On operation these shadows were found to be calcified areas not resembling tuberculosis. In both cases the calcified bodies were shelled out with difficulty. One developed miliary tuberculosis following the operation and the other, after having drained a long time from the incision, had the kidney removed and it was found to be tuberculous. Therefore, in cases where the radiographs show shadows in the cortex, the greatest care should be made to rule out tuberculosis, and not being able to do so, I should recommend letting such shadows alone. Pyelograms are important, of course, to make sure that shadows are in the substance of the kidney and not in a deep calyx.

Pyelograms. There is nothing distinctive in the pyelograms in tuberculosis of the kidney. The appearance does not differ materially from the pyelonephritis of some other organism. The ureter itself will at times show strictured areas, but this is not pathognomonic.

Ponzio, M. Studio radiologico dell' evoluzione dei traumatismi ossei per ferite di guerra ed indicazioni terapeutiche da esso suggerite (A Radiological Study of the Evolution of War Injuries of Bone, with the Therapeutic Indications Suggested Thereby). (*Radiol. med.*, 1919, Vol. 6, 12–25.)

Radiological examination is not merely a means of localizing foreign bodies, but its systematic use can give valuable information on the condition of damaged tissues, and so help in guiding treatment and deciding on prognosis. The author discusses at length the lessons derived from an extensive radiological experience in war wounds of bone. The main factor in these war injuries is, he considers, that there are open wounds, and nearly always infection, so that the majority do not recover in the way that is normal in simple fractures. Another difference between cases due to ordinary trauma and to projectiles of warfare, lies in their greater variety and the greater violence applied by the latter. The x-ray picture varies between a hardly visible crack and complete shattering of the bone; and it is hard to establish a proportional relationship between the trauma and the resulting lesion. The governing factors are the force and shape of the missile, the nature and part of bone struck, whether shaft or epiphysis, long or short bone, and whether a groove, fissure, perforation, true fracture, or shattering results.

Incomplete fracture forms.—In modern war, furrowing is rare, but can be seen in the epiphysis of large bones and on the surface of the skull and the pelvis. The sulcus has often small fissures radiating from it, but they are not easy to demonstrate in cranial and pelvic bones, though the arrangement of scattered fragments of metal will sometimes suggest their position. Isolated fissures are not common, but can be seen; when a projectile with small force strikes tangentially, it produces a linear fissure of the surface. The length of fissure depends on the nature of bone more than on the force of the blow; in long bones it may be extensive, and may also be seen at the side opposite to the point of entry. Fractures of the inner table can also be found after small wounds of the head, and explain persistence of symptoms out of proportion to what was expected from clinical examination.

Perforation is rarely seen in simple form. It may be incomplete, and contain a firmly embedded fragment of shell or grenade; more commonly one sees a hole surrounded by radiating fissures, especially at the point of exit.

The course of these incomplete bone lesions is usually good, but much after-trouble may result from laceration of periosteum, leading to the formation of adhesions or bony enlargement, especially when near joints and after infection. The process of bone repair may be retarded by the presence of a foreign body, or by the establishment of localizing osteitiis or osteomyelitis. Radiograms show that such process is limited to the region of the wound, and seldom spreads. Repair is slow, and solution of bony continuity can be seen for a long time. Perforation leaves little after-trouble, unless it involves joint surfaces or is complicated by injury to other organs. The former may end with decalcification, rarefaction, ankylosis, which can only be appreciated fully by the x-ray picture.

Complete fracture is the more common form of bone injury, and is mostly complicated and comminuted, owing to the great force of modern projectiles. X-rays show in most cases, especially in wounds sustained at close quarters, extensive and minute shattering of the bones, characteristic of an explosive type of violence, with dissemination of bony and metallic fragments in the soft parts around. One has wrongly attributed to "explosive bullets" these results, which are really due to the explosive effect of modern high velocity projectiles at short range. This is proved by examination of captured Austrians and of cases of accidental wounds, which show appearances of an equally explosive type where the use of explosive bullets can be excluded.

The author insists on the necessity of periodical x-ray examination as the surest means of establishing the nature of the condition present at each stage, and the desirability and extent of operation when indicated. He denounces excessive or hasty removal of bony fragments as a frequent cause of useless and flail joints and bony deformities from deficiency of substance. The patients are young, fit, and of full cellular activity; the bone fragments show vigorous efforts at growth, ejecting useless pieces and binding the rest in callus. The growth may even be excessive, and produce obliteration of interosseus spaces, infiltration of muscle, obstruction at joints, and compression of nerves or vessels. These conditions can be elucidated by radiology alone.

Systematic x-ray examination has thrown much light on the nature of calculus and its formation, and on the treatment of pseudarthrosis and delayed and mal-union of fractures. It is more common to find lack of con-

solidation of callus than complete absence of new bony growth. Differentiation between fibrous union and false joint is not always easy, as the radiograph does not always agree with the clinical picture. True pseudarthrosis is relatively rare in war surgery.

The process of osteitis goes on in the superficial layers of the bone and spreads, while a reactive and defensive area appears more deeply in the form of compact bone showing no trabecular structure to x-rays. This limits the infective process, but may later on be an obstacle to closure of cavities. If suppuration lasts long, the osseous reactive tissue is less distinct, the zone of osteitis more extensive, and calcareous osteo-atrophy becomes evident. The healing of the wound is too often taken as a sign that observation may cease, and bad functional results ensue. These can be prevented by proper x-ray supervision, which will reveal conditions likely to benefit by physical treatment or by surgery, or by avoidance of forcible manipulation where a quiescent focus may be lighted up. In a comparison of many cases the most remarkable functional results were seen when there was a combination of surgical treatment with prolonged and systematic physiotherapy. Among points for consideration here the author says that pain in stumps is less commonly due to neuroma than to neuritis of compression, ischemia or distrophy of callus, bony spicules, etc., and seldom to foreign bodies. Pain in joints is often due to osteo-atrophy, which x-rays show may follow even slight injury with prolonged fixation. The consolidation of callus is not the final stage, bony deformity may progress, and local weakness may exist, so these cases should be watched for a very long time.

Fixation by metal wires or screws or bone-grafts should only be done when deformity is excessive, and then only when sepsis is quite gone. When a graft is succeeding its substance can be seen to be invaded by new bone, in less favorable cases it is quickly isolated by a fibrous wrapping and is left useless.

Non-union is now seldom seen, owing to improved technique, of which x-ray control is an important part. In all this work the radiological contribution needs constant and minute attention, anatomical and pathological knowledge, and cannot be efficiently done by nurses, orderlies, or other subordinates.

N. H. M. B.

INDEX TO VOLUME VII